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ताळगांव पठार,
गोंय - ४०३ २०६
फोन : + ९१ - ८६६९६०९०४८

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(Accredited by NAAC with Grade A+)

GU/Acad –PG/BoS -NEP/2025-26/49 Date: 23.04.2026

CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP/2025-26/614 dated 08.12.2025

In supersession to the above referred Circular, the syllabus of Semester III & IV of the **Master of Science in Biochemistry** Programme approved by the Standing Committee of the Academic Council in its meeting held 24th & 25th November 2025, is attached.

The syllabus of Semester II approved earlier by the Academic Council in its meeting held on 13th September 2025 and syllabus of Semester I approved by the Academic Council in its meeting held on 13th & 14th June 2025, is also attached.

The Dean & Vice-Dean (Academic) of the School of Chemical Sciences are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN V LAWANDE
Digitally signed by ASHWIN V LAWANDE
Date: 2026.04.23 16:22:32 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,

1. The Dean, School of Chemical Sciences, Goa University.
2. The Vice-Dean (Academic), School of Chemical Sciences, Goa University.

Copy to:

3. Chairperson, BoS in Chemistry, Goa University.
4. Programme Director, M.Sc. Biochemistry, Goa University.
5. Controller of Examinations, Goa University.
6. Assistant Registrar Examinations (PG), Goa University.
7. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

GOA UNIVERSITY

MASTER OF SCIENCE IN BIOCHEMISTRY

(Effective from the Academic Year 2025-2026)

ABOUT THE PROGRAMME

This program is thoughtfully designed by integrating academic foundations with current research and industry requirements. Graduates of the M.Sc. Biochemistry program will be well-prepared for careers across diverse sectors such as pharmaceuticals, biotechnology, healthcare, agriculture, environmental sciences, and related industries. The curriculum emphasizes practical skills and research training through laboratory work, projects, and a dissertation, providing students with hands-on experience essential for pursuing advanced studies like Ph.D. programs. Equipped with in-depth biochemical knowledge and research proficiency, students will be well-positioned to excel in national competitive examinations such as CSIR-NET, GATE, and other qualifying tests for higher education and research opportunities.

OBJECTIVES OF THE PROGRAMME

1. To develop a strong theoretical and practical foundation in core areas of biochemistry, including genetics, molecular biology, enzymology, metabolism, and structural biology, enabling students to understand the molecular basis of life processes.
2. To equip students with advanced laboratory skills and techniques commonly used in biochemical research, fostering analytical thinking and problem-solving abilities essential for scientific inquiry and innovation.
3. To encourage independent and collaborative research by engaging students in research projects, seminars, and dissertations that promote critical evaluation of scientific literature and the ability to design and execute experiments.
4. To prepare students for professional careers in biotechnology, pharmaceuticals, healthcare, agriculture, and environmental sectors, through industry-relevant curriculum and exposure to real-world scientific applications.
5. To support academic and professional advancement by training students for competitive exams such as CSIR-NET, GATE, and entrance tests for doctoral programs, thereby paving the way for careers in research, teaching, and higher education.

PROGRAMME SPECIFIC OUTCOMES (PSO) M.Sc. Biochemistry	
PSO 1.	Demonstrate comprehensive knowledge of core concepts in biochemistry including biomolecular structure, metabolism, enzymology, cell and molecular biology, immunology, and genetic engineering.
PSO 2.	Develop proficiency in modern biochemical techniques such as chromatography, electrophoresis, spectroscopy, PCR and protein purification, along with safe laboratory practices and data analysis and interpretation skills.
PSO 3.	Apply scientific methodology to design, conduct, and analyze biochemical experiments, enabling critical thinking, hypothesis testing, and problem-solving in research and applied settings and effectively communicate scientific ideas and research findings.
PSO 4.	Integrate biochemical knowledge with other disciplines like biotechnology, microbiology, pharmacology, and bioinformatics to address complex biological and health-related problems.
PSO 5.	Translate theoretical knowledge into innovative applications in areas such as drug discovery, clinical diagnostics, nutraceuticals, agricultural, environmental and industrial biochemistry, leading to successful careers in academia, research, industries and allied sectors.

PROGRAMME STRUCTURE

Master of Science in Biochemistry

Effective from Academic Year 2025-26

SEMESTER I				
Discipline Specific Core (DSC) Courses (16 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**CHB-5000**	Concepts in Biochemistry-I	4	400
2	**CHB-5001**	Analytical Techniques in Biochemistry - I	4	400
3	**CHB-5002**	Concepts in Molecular Biology	4	400
4	**CHB-5003**	Cell and Cancer Biology	4	400
Total Credits for DSC Courses in Semester I			**16**	
Discipline Specific Elective (DSE) Course (4 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**CHB-5201**	Biochemistry Practical – I	4	400
2	**CHB-5202**	Biochemistry Practical – II	4	400
Total Credits for DSE Courses in Semester I			**4**	
Total Credits in Semester I			**20**	

SEMESTER II				
Discipline Specific Core (DSC) Courses				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**CHB-5004**	Concepts in Biochemistry- II	4	500
2	**CHB-5005**	Analytical Techniques in Biochemistry - II	4	500
3	**CHB-5006**	Concepts in Immunology	4	500
4	**CHB-5007**	Clinical Biochemistry	4	500
Total Credits for DSC Courses in Semester II			**16**	
Discipline Specific Elective (DSE) Courses (4 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**CHB-5203**	Biochemistry Practical - III	4	400
2	**CHB-5204**	Biochemistry Practical - IV	4	400
Total Credits for DSE Courses in Semester II			**4**	
Total Credits in Semester II			**20**	

SEMESTER III				
Research Specific Elective (RSE) Courses				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**CHB-6000**	Biochemistry Practical -V	4	500
2	**CHB-6001**	Biochemistry Practical -VI	4	500
3	**CHB-6002**	Industrial Biochemistry	4	500
4	**CHB-6003**	Genetic engineering	4	500
5	**CHB-6004**	Microbes in health and disease	4	500
6	**CHB-6005**	Research Methodology in Biochemistry	4	500
Total Credits for RSE Courses in Semester III			**12**	
Discipline Specific Vocational Elective (DSVE) Courses				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**CHB-6401**	Bioprospecting	4	500
2	**CHB-6402**	Pharmaceutics and Food technology	4	500
3	**CHB-6403**	Nanobiotechnology	4	500
Total Credits for DSVE Courses in Semester III			**8**	
Total Credits in Semester III			**20**	

Discipline Specific Dissertation (DSD) (40 Credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**CHB-6501**	Discipline Specific Dissertation (DSD)	40	500

SEMESTER IV				
Generic Elective (GE) Courses (20 Credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**CHB-6201**	Biostatistics and Bioinformatics	4	500
2	**CHB-6202**	Environmental Biochemistry	4	500
3	**CHB-6203**	Animal physiology and developmental biology	4	500
4	**CHB-6204**	Hormones and Neurochemistry	4	500
5	**CHB-6205**	Advanced Practical in Biochemistry-I	4	500
6	**CHB-6206**	Advanced Practical in Biochemistry-II	4	500
7	**CHB-6207**	Advanced Practical in Biochemistry-III	4	500
		Total Credits in Semester IV	**20**	
		Total Credits in Semester III and IV	**40**	

Discipline Specific Dissertation (DSD) (20 Credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**CHB-6502**	Discipline Specific Dissertation (DSD)	20	500

Blooms Taxonomy Cognitive Levels	
Cognitive Level	**Notations**
K1	Remembering
K2	Understanding
K3	Applying
K4	Analyzing
K5	Evaluating
K6	Create

SEMESTER I

Discipline Specific Core Courses

Title of the Course	Concepts in Biochemistry -I
Course Code	CHB-5000
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To develop concepts about structures, reactivity and functions of different biomolecules. • To understand the metabolism of biomolecules and their regulation in living cells. • To develop and apply concepts about energetics involved in metabolic pathways in terms of number of ATPs • To understand the genetic defects and diseases associated with various metabolic processes	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. classify different biomolecules based on their structure and explain their 3-	PSO1

	dimensional arrangement and biological functions.			
	CO 2. illustrate the metabolic pathways for major macromolecules and recognize the chemical changes occurring at each step based on the functional groups involved.		PSO1, PSO3	
	CO 3. compute the energetics involved in metabolic pathways in terms of number of ATPs and describe the different regulatory mechanisms.		PSO1, PSO3, PSO4	
	CO 4. relate certain common diseases to the malfunctioning of respective metabolic pathways.		PSO1, PSO 3, PSO 4, PSO 5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Introduction to Biomolecules** Origin, aim and scope of Biochemistry; Introduction to various classes of major biomolecules. **1.2 Structure and properties of water** Structure and physico-chemical properties of water, Ionic product of water; Importance of water in biological systems.	**2**	CO1	K1, K2
	1.3 Chemical bonding, Stereochemistry and Reactions a. Properties of covalent bond, non-covalent bonds and their importance in biological systems. b. Brief revision of configurational nomenclature: R & S; D & L; E & Z; cis & trans and syn & anti nomenclature with respect to biomolecules. c. Types of biochemical reactions: oxidation-reduction, condensation, rearrangement, addition, elimination, group-transfer, resonance bond, electrophilic and nucleophilic substitution reactions.	**8**	CO1	K1, K2, K3, K4
Module 2:	**Structure and Biological functions of biomolecules** **2.1 Nucleotides and Nucleic acids** Structure and properties of nucleotides, nucleosides, purine (Adenine, Guanine) and pyrimidine (Cytosine, Thymine, Uracil) bases; Structural features of nucleic	**4**	CO1	K1, K2, K3, K4

	acids (DNA & RNA) and their biological functions.			
	2.2 Carbohydrates Structure, stereochemistry, properties of monosaccharides, disaccharides and polysaccharides (storage, structural and extracellular) and their functions; Complex carbohydrates; peptidoglycan, amino sugars, proteoglycans and glycoproteins.	**6**	CO1	K1, K2, K3, K4
	2.3 Lipids Classification (Bloor's classification), structure and function of major lipid subclasses -Triacylglycerols, Phospholipids, Sphingolipids, glycolipids, Lipoproteins, chylomicrons (miscelles), LDL, HDL and VLDL, steroids, prostaglandins and bile acids; qualitative tests of lipids.	**5**	CO1	K1, K2, K3, K4
Module 3:	**Bioenergetics and Oxidative Phosphorylation** **3.1** Thermodynamics: laws of thermodynamics, mechanism of exergonic and endergonic reactions, redox potential, high energy compounds, ATP structure and significance. **3.2** Aerobic electron transport and oxidative phosphorylation, redox enzymes of ETC, Mitchell's chemiosmotic hypothesis and the role of ATP synthase.	**10**	CO3	K1, K2, K3, K4, K5
Module 4:	**Metabolism of Biomolecules: metabolic pathways, regulations and associated diseases.** **4.1. Carbohydrate metabolism** a. Stoichiometry and bioenergetics, significance of central pathways of carbohydrate metabolism: Glycolysis, TCA, Pentose phosphate pathway, Entner-Doudoroff pathway, glycolate cycle, Gluconeogenesis, gluconeogenesis from TCA intermediates/ amino acids / acetyl-CoA, glucuronic acid pathway and regulatory mechanisms. b. Utilization of sugars such as lactose, galactose, maltose and of polysaccharides such as starch, glycogen. c. Biosynthesis of polysaccharides and sugar interconversions.	**13**	CO2, CO3 CO4	K1, K2, K3, K4, K5

	4.2 Lipid metabolism Oxidation of fatty acids and its energetics: oxidation of saturated and unsaturated (mono and polyunsaturated fatty acids (PUFA), Peroxisomal oxidation of fatty acids (Phytanic acid), Refsum's disease, ketone body formation and their clinical significance, diabetic ketoacidosis, Biosynthesis of fatty acids and regulation, Biosynthesis of triglycerides, cholesterol and phospholipids.	**6**	CO2, CO3, CO4	K1, K2, K3, K4, K5
	4.3 Nucleotides and nucleic acids metabolism a. Purine and pyrimidine nucleotides, Deoxyribonucleotides: biosynthesis and its regulation. b. Biosynthesis of nucleotide coenzymes. c. Catabolism of purine and pyrimidine nucleotides.	**6**	CO2, CO3, CO4	K1, K2, K3, K4, K5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. D. L. Nelson, M. M.Cox , Lehninger Principles of Biochemistry, W.H. Freeman; New York, NY, 7th Ed., 2017. 2. D. Voet, J. G. Voet, C. W. Pratt, Fundamentals of Biochemistry, John Wiley & Sons Inc. Hoboken, New Jersey, 5th Ed., 2016.			
References/ Readings:	3. J. M Berg, L Stryer, J. L Tymoczko, G. J Gatto, Biochemistry, W.H Freeman, New York, NY, 9th Ed., 2019. 4. P. Kuchel, S. Easterbrook-Smith, V. Gysbers, J.M. Guss, D.Hancock, J. Johnston, A. Jones, J. Matthews, Schaum's Outline of Biochemistry, McGraw-Hill Book Co, New York, NY, 3rd Ed., 2009. 5. U. Satyanarayana, U. Chakrapani, Biochemistry, Elsevier; 4th Ed., 2013. 6. R. Singh, R. Goyal, D. R. Ferrier, Lippincott's Illustrated Reviews - Biochemistry, 2nd South Asian Ed., 2024.			

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Title of the Course	Analytical Techniques in Biochemistry – I
Course Code	CHB-5001
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To introduce various bioanalytical techniques for the separation and purification of biomolecules. • To understand the significance of sampling and calibration techniques. • To develop concepts for routine biochemical studies such as chromatography, spectrophotometry, centrifugation, microscopy, and electrophoresis techniques. • To evaluate the utility of various analytical techniques as a qualitative and quantitative tool.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. explain the principles of various separation techniques	PSO2
	CO 2. differentiate between various analytical techniques for separation and purification of biomolecules based on their principles	PSO2
	CO 3. choose appropriate separation techniques and isolate and purify biomolecules	PSO2, PSO3, PSO4

	CO 4. apply the knowledge of these techniques for designing various experiments in research and development.		PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 General principles of analytical biochemistry** a. Selection of valid methods for analysis, Instrumental methods, physiological methods, assessment of analytical methods. b. Quality assurance in analytical biochemistry: quality control and quality assessment, c. Accreditation of laboratories: standard operating procedure and good laboratory practice, sampling for analysis, calibration and graphical representation of data	**4**	CO1, CO2	K1, K2, K3, K4
	1.2 Acid, bases and buffers a. Units used in quantitative biochemical measurements: molarity, normality, ppm and percentage by weight/ volume, concept of pH and measurement using pH electrode and other ion selective electrodes, redox potential (Eh), acid-base associations, pH scale of biological fluids.	**5**	CO1, CO2	K1, K2, K3
	b. Buffers, buffering capacity, mechanism of dissociation of macromolecules, dissociation constants, pKa, pI, solvents (eluotropic series), peroxide values, solubility and affinity constants.	**5**	CO1, CO2	K1, K2, K3
Module 2:	**2.1 Colligative Properties** a. Definitions, Factors affecting and Physiological Applications of Osmosis. b. Measurement of osmotic pressure, Osmoregulation, Adsorption, Colloids, Surface Tension and Viscosity. Numerical Problems based on above concepts.	**4**	CO1, CO2	K1, K2, K3

	2.2 Centrifugation a. Principle of centrifugation, concepts of RCF, different types of instruments and rotors. b. Preparative, differential and density gradient centrifugation, analytical ultra-centrifugation. Determination of molecular weights and other applications, subcellular fractionation.	**8**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
Module 3:	**3.1 Electrophoretic techniques** a. Principles of electrophoretic separation, Types of electrophoresis including paper, cellulose acetate/nitrate and gel (introduction to concepts of slab gel, tube, continuous and discontinuous, etc). b. Gel electrophoresis - types of gels, Agarose, Polyacrylamide gel electrophoresis, SDS- PAGE, Isoelectric Focusing and ampholytes, 2-D, native, gradient gels, PFGE, DGGE, TGGE. c. Capillary electrophoresis - instrumentation, sample introduction in CE, types of CE, electrophoretic mobility and electroosmotic mobility, total mobility, efficiency and resolution in CE column. d. Separation of neutral molecules by Micellar electrokinetic chromatography. e. Staining strategies and procedures: Coomassie Brilliant blue R/G 250, Silver, Fluorescent stains Flamingo, Oriole, SYPRO- Ruby; Stain-free gels. f. Examples of separation of biomolecules by electrophoresis.	**10**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
	3.2 Solvent extraction a. Principle, types of extractions and applications. b. Separations based on partitioning between phases based on chemical nature and polarity of analyte. c. Introduction to Soxhlet apparatus, solid phase extraction, microwave-assisted extraction, ultrasound-assisted extraction, counter-current extraction	**5**	CO1, CO2	K1, K2, K3, K4
	3.3 Dialysis a. Principles and applications of equilibrium dialysis and ultrafiltration and lyophilization.	**5**	CO1, CO2 CO3	K1, K2, K3

	b. Dialysis and Concentration, reverse dialysis. c. Artificial membranes, semi-permeable membranes, Donnan membrane equilibrium. Biological significance of osmosis and micelles.			
Module 4:	**4.1 Chromatographic techniques:** a. Introduction to chromatography: Principle of chromatographic techniques, terms and parameters used in chromatography, classification of chromatographic methods, concept of mobile phases; gradient elution (concave, convex and linear) and stationary phases. b. Basic principles, instrumentation and application of thin- layer, paper chromatography, column chromatography, HPLC, GC, ion-exchange chromatography, affinity chromatography, molecular exclusion chromatography and adsorption chromatography. c. Special chromatographic techniques for nucleic acids: DEAE- cellulose chromatography, MAK hydroxyl-apatite chromatography. d. Introduction to Supercritical Fluid Chromatography and hyphenated techniques like LCMS, GCMS.	**14**	CO1, CO2 CO3, CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	K. Wilson, J. Walker, Principles and Techniques of Practical Biochemistry; Cambridge University Press, England, 7th Ed. 2010.			
References/ Readings:	1. G. D. Christian, P. K. Dasgupta, K. A. Schug, Analytical Chemistry, John Wiley & Sons, United States of America, 7th Ed., 2013. 2. D. J. Homes, H. Peck, Analytical Biochemistry, Pearson Education Limited, England, 3rd Ed, 1998. 3. A. Skoog Douglas, F. James Holler, Stanley R. Crouch, Principles of Instrumental Analysis, Cengage India Pvt. Ltd., Noida, Uttar Pradesh, India, 7th Ed, 2016. 4. R. A. Day & A.L. Underwood, Quantitative Analysis, Pearson Education India, 6th Ed, 2015. 5. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental methods of Analysis, HCBS Publishing, India, 7th Ed, 2004.			

Title of the Course	Concepts in Molecular Biology
Course Code	CHB-5002
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To acquaint the students with the basic concepts of inheritance. • To introduce nucleic acids' structure, folding and packaging inside living cells and viruses. • To acquaint the students with concepts of DNA damage, the repair mechanisms initiated by the cell. • To understand gene expression and regulation in prokaryotes and eukaryotes.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. outline and explain the fundamental concepts of genetics like structure and packaging of nucleic material.	PSO1, PSO2, PSO3, PSO4,
	CO 2. illustrate and explain the mechanisms of DNA damage, repair and recombination.	PSO1, PSO3, PSO4
	CO 3. describe and discuss the process of expression of genes in prokaryotes and eukaryotes	PSO1, PSO2, PSO3, PSO4, PSO5

	CO 4. explain basic molecular processes that occur within the cell.		PSO1, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Basic concepts of Mendelian Genetics** Mendel's Principles, Mendel's experiment, allele, wild-type and mutant alleles, dominant and recessive alleles, homozygous and heterozygous, genotype, phenotype.	**3**	CO1, CO3, CO4	K1, K2,
	1.2 Laws of inheritance Mendel's law of inheritance, Law of segregation, monohybrid cross, test cross, Law of independent assortment, incomplete dominance and codominance, multiple alleles.	**4**	CO1, CO3, CO4	K1, K2, K3, K4, K5
	1.3 Prediction, expression and probability Predicting blood groups of progeny, lethal alleles, penetrance and expressivity, Predicting outcome of genetic crosses.	**3**	CO1, CO3, CO4	K1, K2, K3, K4, K5, K6
Module 2:	**2.1 Structure and properties of DNA** DNA as genetic material: Structure of DNA and RNA, Types of DNA based on their structure and their importance in cell (A-DNA, B-DNA, Z-DNA), Types of DNA based on the functionality and their importance in cell (Satellite DNA, Palindrome DNA, Repetitive DNA).	**4**	CO1, CO3, CO4	K1, K2, K3, K4
	2.2 Structure and properties of RNA Types of RNA (mRNA, antisense mRNA, rRNA, tRNA, siRNA), their structure and functions.	**3**	CO1, CO3, CO4	K1, K2, K3, K4, K5
	2.3 Functions and properties of DNA Fundamental functions of DNA, Buoyant density, melting temperature (Tm), DNA reassociation kinetics (Cot curve analysis), DNA methylation and epigenetic effects (Agouti gene methylation, maternal diet and offspring coat colour).	**5**	CO1, CO3, CO4	K1, K2, K3, K4, K5

Module 3:	**3.1 Genome organization and Packaging** a. Viruses (generalized and specialized) b. DNA packaging in prokaryotes c. Eukaryotes (nucleosomes, histones, chromatin and chromosome; primary, secondary and tertiary packaging). d. Heterochromatin and euchromatin, Importance of structural features of chromosome (telomere, centromere and repetitive sequences), Functions of the chromosomes.	**6**	CO1, CO2, CO4	K1, K2, K3, K4, K5
Module 4:	**4.1 Model organisms and Mechanisms of gene transfer** a. *Escherichia coli* as a model prokaryotic organism. b. Yeast as a model eukaryotic organism. c. Mechanisms of Gene Transfer: transformation, transduction, conjugation.	**3**	CO1, CO2, CO4	K1, K2, K3, K4
	4.2 Plasmids Introduction to plasmids, types of plasmids, artificial plasmids.	**2**	CO1, CO2, CO4	K1, K2, K3, K4
Module 5:	**5.1 Mechanisms of DNA damage** Mutations and mutagenic agents: Types of mutations (point mutations: transitions and transversions, frameshift mutations, forward mutations, reverse mutations, suppressor mutations), Role of Mutagenic agents (spontaneous and induced mutagenic agents).	**4**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
	5.2 Mechanisms of DNA repair Direct (Photoreactivation) and Indirect repair (Base excision repair, NER, Mismatch repair, recombination repair, Error prone repair), SOS response.	**4**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
	5.3 Mechanisms of Genetic recombination Homologous and site-specific recombination, Role of synaptonemal complex, lamp brush chromosomes, chi sequences, Rec BCD system, Role of Rec A, Ruv	**4**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5

	A, B and C, Holliday junction model.			
Module 6:	**6.1 Flow of genetic information and expression of genes in prokaryotes and eukaryotes, Concept of Central Dogma** a. **Replication:** replication of DNA, semi-conservative nature of DNA replication. b. **Transcription:** transcription factors and machinery, formation of transcription initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation, and termination, RNA to DNA (reverse transcription); Post-transcriptional modifications: attenuation, riboswitches, alternate splicing, RNA interference, RNA processing, RNA editing, polyadenylation and RNA transport. c. **Translation:** structure of Ribosome (eukaryotes and prokaryotes), formation of translation initiation complex, initiation factors and their role in regulation of initiation of translation, elongation and elongation, factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post translational modification of proteins.	**11**	CO3, CO4	K1, K2, K3, K4, K5
Module 7:	**7.1 Control of gene expression at transcription and translation level** a. Regulation of gene the expression of prokaryotic and eukaryotic genes. b. Role of chromatin in gene expression and gene silencing. c. Role of Recognition sequences or motifs of gene regulatory proteins, Genetic switches and their role in gene expression.	**4**	CO3, CO4	K1, K2, K3, K4, K5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. J.D. Watson, Molecular Biology of the Gene. Pearson/Benjamin Cummings, United States, 7th Ed, 2013. 2. B. Alberts, A. Johnson, Molecular Biology of Cell. Garland Science, United States of America, 2014. 3. N. Craig, O. Cohen-fix, R. Green, Molecular Biology: Principles of Genome function. Oxford University Press, England, 5th Ed, 2014.			

References/ Readings:	1. H. Lodish, A. Berk, P. Matsudaira, C.A. Kaiser, M. Krieger, M.P. Scott, L. Zipursky, & J. Darnell, Molecular Cell Biology. W.H. Freeman, United States of America, 5th Ed., 2008. 2. A. Vologodskii, The Basics of Molecular Biology. Springer International Publishing AG, 1st Ed, 2022 3. P.K. Gupta., Cell and Molecular Biology, Rastogi Publications, 5th Ed, 2019

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Title of the Course	Cell and Cancer Biology
Course Code	CHB-5003
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• Offering detailed knowledge about cell biology and various cellular organelles. • Understanding the communication pathways associated with cellular processes. • Provide insights on basic cell culture techniques and their current applications. • Introducing the fundamental concepts of cancer biology.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. describe the cell structure, various cellular organelles and their functions and the processes of transport across cell membranes.	PSO1
	CO 2. understand cell division and cell cycle mechanisms and various cellular communication pathways along with their significance.	PSO1

	CO 3. apply the basic cell culture techniques needed to work in a biological research laboratory.		PSO1, PSO2, PSO4, PSO5	
	CO 4. understand the biochemistry of cancer development, causes and its classification.		PSO1, PSO4, PSO5	
	CO 5. prepared for advanced courses in life science such as Neurochemistry and hormones, Immunology, Clinical biochemistry, etc.		PSO1, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Introduction to cell biology and Biomembranes** **1.1 Structural organization of the cell** Prokaryotic and eukaryotic cells, animal and plant cells; Structure and functions of cellular and subcellular organelles.	**10**	CO1, CO5	K1, K2
	1.2 Biological membrane structure and function Structure and functions of membrane, Transport across cell membrane: Passive and active transport of molecules across biological membranes, Membrane pumps.	**5**	CO1, CO5	K1, K4
Module 2:	**2. Cell Cycle and Cellular Communication** **2.1 Cell division and cell cycle** Introduction to Cell cycle: Mitosis, Meiosis, Regulation of the cell cycle, Flow cytometry in cell cycle.	**5**	CO2, CO5	K1, K2, K4
	2.2 Cellular communication and Cell signalling Signal transduction pathways: Signalling molecules and their receptors, G-Protein Coupled receptors, Receptor Tyrosine Kinases, MAP kinase pathway and JAK-STAT pathway, Light signalling in plants, Bacterial chemotaxis and quorum sensing; Apoptosis: intrinsic and extrinsic pathways.	**10**	CO2, CO5	K4
Module 3:	**3. Cell and Tissue Culture Techniques and Applications** **3.1 Plant tissue culture**	**5**	CO3, CO5	K1, K2, K3

	Introduction to plant tissue culture and various requirements, Preparation for tissue culture, Tissue culture methodologies, Applications of PTC.			
	3.2 Animal tissue culture Introduction to animal tissue culture and various requirements, Typical cell lines, growing mammalian cells and general maintenance of cells, Applications of ATC.	**5**	CO3, CO5	K1, K2, K3
	3.3 Microbial culture Introduction to microbial culture and requirements, Microbial Nutrition and Growth, Applications in industry	**5**	CO3, CO5	K1, K2, K4
Module 4:	**4.1 Biochemistry of cancer** Etiology of cancer cells, types, Properties of cancer cells, Biochemistry and pathways of cancerous growth, Epigenetic factors of cancer, Mutagens and carcinogens, Apoptosis in carcinogenesis, Metastasis, Tumor markers in diagnosis, Cancer therapies.	**15**	CO4, CO5	K3
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. Karp, G.; Cell and Molecular Biology: Concepts and experiments; John Wiley and Sons Inc.; New York, 8th Ed., 2015. 2. Lodish, H.; Berk A.; Kaiser, C. A; Krieger, M.; Bretscher, A.; HiddePloegh, Amon A.; Martin, K. C.; Molecular Cell Biology; W.H. Freeman and Company; New York, 8th Ed., 2016. 3. Freshney, I.; Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell; Hoboken, New Jersey, 7th Ed., 2016. 4. DeRobertis, E.D.P.; DeRobertis Jr. E.M.F; Cell and Molecular Biology; Saunders; United States, 8th Ed., 2017. 5. Pelczar, M.; Reid, R.D.; Chan E.C.S.; Microbiology. MacGraw-Hill; United States, 5th Ed., 2001.			
References/ Readings:	1. Smith, R.H.; Plant tissue culture: technique and experiments; Academic Press; Amsterdam, 3rd Ed., 2012. 2. Wood, D., Sandman, K., & Willey, J. Prescott's Microbiology. McGraw-Hill Companies; United States of America, 12th Ed., 2022.			

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Discipline Specific Elective (DSE) Courses

Title of the Course	Biochemistry Practical – I
Course Code	CHB-5201
Number of Credits	4
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• Understanding principles, theory and calculations of each experiment. • Gain hands on preparation of all the solutions and to standardize solutions individually. • Develop basic understanding and skills of various instruments and techniques used for analyzing biomolecules • Train in essential molecular and cell biology techniques, including DNA isolation, PCR, and cell culture methods for biological research.	
Course Outcomes:	The students will be able to	**Mapped to PSO**
	CO 1. skillfully handle biomolecules and to quantify biomolecules with appropriate methods.	PSO1, PSO4, PSO5

	CO 2. choose between various separation techniques and carry out separation and purification of biomolecules.		PSO2, PSO3, PSO4, PSO5	
	CO 3. carry out genomic DNA isolation and PCR amplification for its use in molecular research.		PSO2, PSO4, PSO5	
	CO 4. demonstrate the various cell culture techniques needed to work in a biological research laboratory.		PSO2, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Fundamentals of Biochemistry** a. Estimation of reducing sugars by DNSA method. b. Colorimetric methods for protein estimation by Folin-Ciocalteau methods. c. Estimation of total sugars by anthrone method. d. Estimation of DNA by diphenylamine method. e. Estimation of RNA by orcinol reaction. f. Estimation of cholesterol by Zak's method. g. Estimation of iodine value of oils and fats. h. Qualitative determination of lipids, proteins and sugars.	**30**	CO1	K1, K2, K3, K4, K5
Module 2:	**2. Analytical Techniques in Biochemistry - I** a. Calibration of pH meter using standard buffer solutions and determination of pH of given unknown solution b. Preparation of acetate and phosphate buffer and measuring their pH values using pH meter. c. Separation of mixtures of compounds (organic compounds including biomolecules) based on their chemical nature using solvent extraction. d. Separation of lipids by thin layer chromatography. e. Separation of carbohydrates by thin layer chromatography. f. Column chromatographic separation of mixtures of compounds (organic	**30**	CO2	K1, K2, K3, K4, K5

	compounds including biomolecules). g. Separation of pigments by paper chromatography. h. Determination of turbidity of biological/ environmental sample using turbidimetry. i. Separation of mixtures of compounds (organic compounds including biomolecules) using HPLC. j. Separation of mixtures of compounds (organic compounds including biomolecules) by thin layer chromatography.			
Module 3:	**3. Concepts in Molecular Biology** a. Procuring and maintenance of *E. coli* culture. b. Isolation of genomic DNA of *E. coli* cells. c. Estimation of quantity and purity of DNA by spectrophotometry. d. Agarose gel electrophoresis of bacterial DNA. e. PCR amplification of a specific gene using bacterial genomic DNA as a template. f. Agarose gel analysis of PCR product to determine amplicon size. g. Isolation of plasmid DNA from *E. coli* cells. h. Restriction enzyme digestion of plasmid DNA.	**30**	CO3	K1, K2, K3, K4, K5
Module 4:	**4. Cell and Cancer Biology** a. Use of aseptic techniques of sterilization and disinfection in microbial culture. b. Isolation and enumeration of fungal and bacterial cells from an environmental sample such as soil and water. c. Primary identification and characterization of bacterial and fungal cells based on colony morphology. d. Determining the Gram character of a bacterial species via Gram's staining technique. e. Tentative identification of fungal isolates using lactophenol cotton blue staining technique.	**30**	CO4	K1, K2, K3, K4, K5

	f. Isolation of animal tissues, culturing and maintenance of animal cell lines. g. Microscopic examination, cell counting, viability testing using a haemocytometer. h. Surface sterilization of plant material, excision, aseptic tissue transfer i. Induction of callus using plant explant and micropropagation.			
Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.			
Texts:	1. Wilson K, Walker J; Principles and Techniques of Practical Biochemistry; Cambridge University Press; New York, 7th Ed., 2010. 2. Sawhney, S. K., Singh, R.; Introductory Practical Biochemistry; Narosa Publishing House; New Delhi, India, 2nd Ed., 2005. 3. Freshney, I. R.; Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell; Hoboken, New Jersey, 7th Ed., 2016.			
References/ Readings:	1. Kumar, D. K.; Plant Tissue Culture; New Central Book Agency; Kolkata, India,1st Ed., 2008. 2. J. Kenkel, Analytical Chemistry for Technicians, Lewis publishers, USA, 3rd ed, 2002. 3. S. Carson and H.B. Miller, Molecular Biology Techniques: A Classroom Laboratory Manual. Elsevier Science Publishing Co. Inc USA, 2019			

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Title of the Course	Biochemistry Practical – II
Course Code	CHB-5202
Number of Credits	4
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• Understanding principles, theory and calculations of each experiment. • Gain hands on preparation of all the solutions and to standardize solutions individually. • Develop basic understanding and skills of various instruments and techniques used for analyzing biomolecules • Train in essential molecular and cell biology techniques, including DNA isolation, PCR, and cell culture methods for biological research.	
Course Outcomes:	The students will be able to	**Mapped to PSO**
	CO 1. skillfully handle biomolecules and to quantify biomolecules with appropriate methods.	PSO1, PSO4, PSO5
	CO 2. choose between various separation techniques and carry out separation and purification of biomolecules.	PSO2, PSO3, PSO4, PSO5
	CO 3. carry out genomic DNA isolation and PCR amplification for its use in molecular research.	PSO2, PSO4, PSO5

	CO 4. demonstrate the various cell culture techniques needed to work in a biological research laboratory.		PSO2, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Fundamentals of Biochemistry** a. Colorimetric methods for protein estimation by Biuret method. b. Estimation of total sugars by phenol sulfuric acid method. c. Estimation of determination of reducing sugar by Lane Eynon method. d. Estimation of DNA by Nile blue method. e. Estimation of RNA by orcinol reaction. f. Estimation of cholesterol by Folch method. g. Estimation of acid value of oils and fats	**30**	CO1	K1, K2, K3, K4, K5
Module 2:	**2. Analytical techniques in Biochemistry-I** a. To study bacterial growth curve using turbidimetric method. b. Separation of proteins using DEAE cellulose column chromatography. c. Separation of pigments by thin layer chromatography. d. Separation of amino acids by thin layer chromatography. e. Preparation of citrate and Tris-HCl buffer and measuring their pH values using pH meter. f. Extraction of lipids from biological samples using solvent extraction techniques. g. Separation of amino acids by paper chromatography. h. Separation of mixtures of compounds (organic compounds including biomolecules) by thin layer chromatography.	**30**	CO2	K1, K2, K3, K4, K5
Module 3:	**3. Concepts in Molecular biology** a. Procuring and maintenance of *Saccharomyces cerevisiae* culture. b. Isolation of genomic DNA of *S. cerevisiae* cells.	**30**	CO3	K1, K2, K3, K4, K5

	c. Estimation of quantity and purity of DNA by spectrophotometry. d. Agarose gel electrophoresis of yeast DNA. e. PCR amplification of a specific gene using yeast genomic DNA as a template. f. Agarose gel analysis of PCR product to determine amplicon size. g. Isolation of plasmid DNA from *S. cerevisiae* cells. h. Restriction enzyme digestion of plasmid DNA.			
Module 4:	**4. Cell and Cancer Biology** a. Laboratory safety protocols and Preparation of media and sterilization techniques. b. Isolation and enumeration of bacterial and fungal cultures from various food samples. c. Identification of bacterial and fungal isolates based on morphological and biochemical identification techniques. d. Tentative identification of fungal isolates using wet mount technique. e. Determination of efficacy of cell disruption by sonication. f. Density gradient separation of cell biomolecules. g. Study of bacterial growth curve using spectrophotometer. h. Antibiotic sensitivity testing using Kirby-Bauer disk diffusion method	**30**	CO4	K1, K2, K3, K4, K5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. Wilson K, Walker J; Principles and Techniques of Practical Biochemistry; Cambridge University Press; New York, 7th Ed., 2010. 2. Sawhney, S. K., Singh, R.; Introductory Practical Biochemistry; Narosa Publishing House; New Delhi, India, 2nd Ed., 2005. 3. Freshney, I. R.; Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell; Hoboken, New Jersey, 7th Ed., 2016.			
References/ Readings:	1. Kumar, D. K.; Plant Tissue Culture; New Central Book Agency; Kolkata, India,1st Ed., 2008. 2. J. Kenkel, Analytical Chemistry for Technicians, Lewis publishers, USA, 3rd Ed, 2002			

	3. S. Carson and H.B. Miller, Molecular Biology Techniques: A Classroom Laboratory Manual. Elsevier Science Publishing Co. Inc USA, 2019

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SEMESTER II

Discipline Specific Core (DCS) Courses

Title of the Course	Concepts in Biochemistry -II
Course Code	CHB-5004
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil
Course Objectives:	• To develop knowledge about protein structure, function and its metabolism and regulation pathways. • To introduce classification, nomenclature and types of enzymes and develop comprehensive knowledge of enzyme properties, including enzyme activity, substrate specificity, and kinetics of enzyme catalysed reaction and their inhibition. • To understand the mechanisms of enzyme catalysis and enzyme regulation and their significance in metabolic pathways. • To analyse and employ different analytical techniques for isolation and purification of enzymes.

Course Outcomes:	Students will be able to:		**Mapped to PSO**	
	CO1. explain protein structure, functions and outline their metabolic and regulatory pathways.		PSO1, PSO3	
	CO2. classify enzymes and elaborate on their types and properties, and evaluate the kinetics involved in enzyme catalysed reactions and their inhibition.		PSO1, PSO3	
	CO3. analyse the mechanisms of enzyme catalysis and their regulation and illustrate on their significance in biochemical pathways		PSO1, PSO3, PSO 4, PSO5	
	CO4. develop methods for the isolation and purification of enzymes using various analytical techniques.		PSO1, PSO2, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Amino acids, Peptides and Proteins** a. Amino acids: Structure, Classification, b. Physico-chemical properties of amino acids and role of non-protein amino acids. c. Peptides: Peptides of physiological significance, peptide bond. Proteins: Primary (importance of primary structure),secondary (alpha-helix, β –structure, β-helix, super secondary structure), tertiary (stabilizing forces, unfolding/refolding) and quaternary structures (e.g.: Haemoglobin, Myoglobin)	**6**	CO1	K1, K2, K3
	1.2 Amino acid and protein metabolism a. General reactions of amino acid metabolism: Transamination, decarboxylation, oxidative and nonoxidative deamination of amino acids. b. Special metabolism of methionine, histidine, phenylalanine, tyrosine, tryptophan, lysine, valine, leucine, isoleucine, and polyamines. Urea cycle and its regulation. c. Overview of biosynthetic pathways of amino acids and their regulation; Assimilation of ammonia, biosynthesis of essential and non-essential amino acids, regulation of glutamine synthetase and the aspartate family of amino acids d. Protein metabolism: Protein hydrolysis, disulfide, Mechanism of protein degradation	**12**	CO1	K1, K2, K3, K4

Module 2:	**2.1 Introduction to enzymes** a. Simple enzymes, conjugated enzymes. b. Coenzymes and cofactors and their role in enzyme activity, prosthetic group, and metalloenzymes. c. Enzyme Commission nomenclature and classification of enzymes d. Structure and specific sites: Enzyme structure, enzyme substrate complex, binding sites, concept of active site, stereospecificity e. Enzymes as catalysts: lock and key model, induced fit model f. Mechanism of action of enzymes as catalysts: Role of enzymes to increase reaction rates, transition state theory, and activation energy.	**6**	CO2	K1, K2, K3
	2.2 Enzyme Kinetics and Enzyme-Substrate Interactions a. Basic concepts of Kinetics: Enzyme activity, Enzyme Assay, specific activity (Definition and units). b. Methods for Enzyme Kinetics: Michaelis-Menten Equation: formula and derivation, Lineweaver-Burk plot for one-substrate reactions. c. Parameters of Kinetics: Significance of Vmax and Km, Kinetics of bi- or multi-reactant systems. d. Factors affecting Enzyme catalysis: Effect of pH, temperature on enzymes, Enzyme inhibition: reversible (competitive, uncompetitive, mixed inhibition) and irreversible inhibition e. Enzyme turnover: Ks, Kd, and measurement of enzyme turnover, Correlation between the rates of enzyme turnover, structure and function of enzymes, significance of enzyme turnover.	**11**	CO2	K1, K2, K3, K4, K5
Module 3:	**3.1 Mechanism of Enzyme Action and Enzyme regulation** a. Active centre of Enzyme catalysis: Determination of the active centre of catalysis of enzymes b. Identification of functional groups; Factors affecting catalytic efficiency: proximity, orientation, strain; Enzyme catalytic strategies: covalent, acid-base catalysis, metal	**12**	CO3	K1, K2, K3, K4

	ion catalysis. c. Mechanism of action of enzymes: lysozyme, chymotrypsin, aspartate protease, RNase A. d. Enzyme Regulation: control of enzyme activity, control of enzyme availability, inhibitor or enhancer molecules. e. Mechanisms of enzyme regulation and their significance in Metabolism: Allosteric regulation (aspartate transcarbamylase), Reversible covalent modification (glycogen phosphorylase), Feedback inhibition and feedback repression.			
Module 4:	**4.1 Enzyme systems** a. Zymogens and Isozymes. b. Multienzyme systems: disassociated system (catabolic enzymes), multienzyme complex (pyruvate dehydrogenase), membrane-bound system (electron carrying enzymes). c. Nucleic acid as catalysts: Ribozyme, DNAzyme; Abzyme.	**8**	CO3	K1, K2, K3, K4, K5
	4.2 Enzyme purification techniques a. Isolation of intracellular and extracellular enzymes from plant and animal tissues and microbial cells. b. Application of separation and purification techniques for proteins: differential centrifugation, salt precipitation, dialysis, ultrafiltration, molecular exclusion chromatography, affinity chromatography, ion exchange chromatography. c. Determination of Enzyme activity by different methods; Purification table (specific activity and fold purification as criteria of purity of enzymes). d. Zymograms e. Molecular weight determination by SDS-PAGE and gel filtration	**5**	CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. D. L. Nelson, M. M. Cox, Lehninger: Principles of Biochemistry, W.H. Freeman and Co. Ltd.; New York, 7th Ed., 2017. 2. D. Voet, J. G. Voet, C. W. Pratt, Fundamentals of Biochemistry, John Wiley & Sons Inc. Hoboken, New Jersey,			

	5th Ed., 2016.
References/ Readings:	1. D.T. Plummer, An introduction to practical biochemistry. TATA McGraw Hill, New York, 3rd Ed., 2006. 2. R.O. Okotore, Essentials of Enzymology. Xlibris-US, New York, 1st Ed., 2015. 3. T.D.H. Bugg, Introduction to enzymes and coenzyme chemistry. Wiley-Blackwell, London, 3rd Ed., 2012. 4. J. M Berg, L Stryer, J. L Tymoczko, G. J Gatto, Biochemistry, W.H Freeman and Co. Ltd., New York, NY, 9th Ed., 2019. 5. N. Price and L. Stevens, Fundamentals of Enzymology. Oxford University Press, New York, 3rd Ed., 1999.

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Title of the Course	Analytical Techniques in Biochemistry -II
Course Code	CHB-5005
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To introduce various electro-analytical, imaging and spectral characterization techniques for analysis. • To evaluate the utility of various analytical techniques as a qualitative and quantitative tool. • To understand and apply techniques and instruments used in the determination of macromolecular structures. • To understand and explore the use of tracer techniques for studying metabolic pathways and related biochemical processes.	
Course Outcomes:	Students will be able to:	Mapped to PSO
	CO 1. explain the principles of various electro-analytical, imaging and spectral characterization techniques.	PSO2
	CO 2. differentiate between various analytical techniques based on their theory and sensitivity achieved.	PSO2

	CO 3. choose between various techniques of structure elucidation based on the information desired and interpret the data obtained to a fair level.		PSO2, PSO3, PSO4, PSO5	
	CO 4. apply the knowledge of various techniques for designing experiments in research and development.		PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Biosensors and its application:** a. Introduction and principles of biosensors. b. Components of biosensors: biorecognition elements (enzymes, antibodies, DNA, Molecular imprinted polymers), transducers, signal detection platform c. Types of biosensors: potentiometry, conductometry, coulometry and voltammetry. d. Applications: clinical and environmental analysis.	**7**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
	1.2 Radioisotope techniques a. Nature of radioactivity and its detection, measurement of radioactivity, Disintegration kinetics. b. Radio-activity counters and radioanalysis – GM Counter, Scintillation Counter, Isotope dilution analysis. c. Theory and application of Autoradiography and radiorespirometry. d. Tracer techniques for metabolic pathways. e. Safety measures in handling radioisotopes. f. Non-radioactive detection methods:	**7**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
Module 2:	**2.1 Optical methods of analysis: Theory, instrumentation and applications** a. Nephelometry. b. Turbidimetry. c. UV-visible spectrophotometry. d. Fluorometric analysis. e. Flame emission photometry f. Atomic absorption spectrophotometry	**14**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6

	g. Flowcytometry.			
Module 3:	**3.1 Microscopy and Bioimaging** a. Imaging living cells and tissues and measuring cellular dynamics. b. Theory of microscopy, basic aspects of compound microscope. c. Light microscopy: Theory, instrumentation and applications of bright field, dark field, phase-contrast, inverted microscopy. d. Principle and application of fluorescence microscopy, confocal scanning microscopy, epifluorescence and immuno-fluorescence microscopy. e. Electron microscopy: Theory, instrumentation and applications of scanning electron microscopy (SEM) and transmission electron microscopy (TEM). f. Atomic force microscopy (AFM): Theory, instrumentation and applications. g. Optical tweezers: Introduction and applications.	**11**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
Module 4:	**4.1 Techniques for structure determination of biomolecules: Principle, theory, instrumentation, data interpretation and applications** a. FTIR, NMR, ESR b. Single crystal X-ray diffraction, c. Optical rotatory dispersion and circular dichroism.	**14**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
	4.2 Mass Spectrometry for biomolecules a. Principle, components, working and applications of mass spectrometer. b. Different types of ionization methods used in mass spectrometer (CI, EI, ESI, FAB). c. Different types of mass analysers used in mass spectrometers (magnetic sector, ion trap, quadrupole), MALDI-MS, MALDI-TOF-MS, ICP-MS. d. Structural information by tandem mass spectrometry.	**7**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. K. Wilson, J. Walker, Principles and Techniques of Practical Biochemistry; Cambridge University Press, England,			

	7th Ed., 2010. 2. D. A. Skoog, D. M. West, F. J. Hollar, S. R. Crouch, Fundamentals of Analytical Chemistry, Cengage learning, USA, 9th Ed., 2014. 3. W. Kemp, Organic Spectroscopy, Palgrave Macmillan, New York, 1991.
References/ Readings:	1. de Hoffmann, E.; Stroobant, V.; Mass Spectrometry: Principles and Applications; John Wiley & Sons Ltd; England, 3rd Ed., 2007. 2. Parakhia, M. V.; Tomar, R. S.; Patel, S.; Golakiya, B. A.; Molecular Biology and Biotechnology: Microbial Methods; New India, 1st Ed., 2010. 3. R.M. Silverstein, F. X. Webster, D.Kiemle, D. Bryce, S. Samant, V. S. Nadkarni, Spectrometric Identification of Organic compounds, An Indian Adaptation John Wiley & Sons Inc., New Delhi, India, 8th Ed., 2022. 4. R. F. Egerton, Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM, Springer, Switzerland 2nd Ed., 2016. 5. G. D. Christian, P. K. Dasgupta, K. A. Schug, Analytical Chemistry, John Wiley & Sons, United States of America, 7th Ed., 2013. 6. D. J. Homes, H. Peck, Analytical Biochemistry, Pearson Education Limited, England, 3rd Ed., 1998. 7. A. S. Douglas, F. J. Holler, S. R. Crouch, Principles of Instrumental Analysis, Cengage India Pvt. Ltd., Noida, Uttar Pradesh, India, 7th Ed., 2016. 8. R. A. Day & A.L. Underwood, Quantitative Analysis, Pearson Education India, 6th Ed., 2015. 9. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental methods of Analysis, HCBS Publishing, India, 7th Ed., 2004.

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Title of the Course	Concepts in Immunology
Course Code	CHB-5006
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To provide an insight into the components of the immune system, their development, their functions and their mechanisms of action. • To understand the role of the immune system in eliciting immune response. • To develop knowledge on the role of immune system in human health and disease conditions. • To create understanding of vaccine development and diagnostic strategies involving the immune system.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. describe the organization and functions of immune cells and organs, and analyze the structural and functional aspects of antigens and antibodies.	PSO1
	CO 2. apply the principles of innate and adaptive immunity to explain defense mechanisms against pathogens.	PSO1, PSO4

	CO 3. analyze the genetic basis of antibody diversity, and evaluate immune regulatory mechanisms and their roles in human health and disease conditions.		PSO1, PSO4, PSO5	
	CO 4. evaluate and develop vaccine strategies for health and apply appropriate immunological techniques for experimental and diagnostic approaches.		PSO1, PSO2, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Cells and organs of immune system; concepts of antigens and antibodies** **1.1 Cells of the immune systems** a. Hematopoiesis; Lymphocytes and Antigen presenting cells (APCs). b. T cells: Maturation; Activation and Proliferation; T cells subsets and their functions; T cell receptor; Structure and organization. c. B cells: Maturation, Activation and Proliferation; Functions; T cell receptor, Structure and Organization.	**6**	CO1	K1, K2
	1.2 Organs of the immune system: Primary and secondary lymphoid organs: Structure and function.	**3**	CO1	K1, K2
	1.3 Antigens and Antibodies a. Antigens: Chemical complexity and molecular property of Antigens; Immunogens; Haptens; Epitopes; Antigenicity and Immunogenicity. b. Antibodies: i. Structure and function of various classes of immunoglobulins. ii. Antigenic determinants on immunoglobulins. iii. Monoclonal and Polyclonal antibodies: their production by hybridoma technology and clinical uses.	**6**	CO1	K1, K2, K3
Module 2:	**2. Immune Response** **2.1 Innate immune response** a. Mechanical barriers to infection.	**7**	CO2	K1, K2, K3

	b. Physiological factors contributing to innate immunity. c. Inflammatory response: Mechanism and mediators involved. d. Phagocytic system: Activation of macrophages and mechanism of phagocytosis. e. Complement system: Components; Properties; function; Activation of complement pathways (Classical, Alternative and lectin pathways); Consequences of complement activation; Complement fixation test.			
	2.2 Adaptive immune response a. Cell-mediated and Humoral immunity: primary and secondary immune response. b. Major Histocompatibility Complex: Molecular organization of MHC molecules (H-2, HLA); Structure of MHC molecules; Class I MHC-peptide and Class II MHC-Peptide interactions; self MHC restriction of T cells; Gene organisation and concept of MHC polymorphism; MHC expression and its regulation. c. Antigen processing and presentation pathways: Cytosolic and Endocytic pathways.	**8**	CO2	K1, K2, K3, K4
Module 3:	**3. Immunogenetics and Clinical Immunology** **3.1 Immunogenetics** a. Theories of antibody formation. b. Generation of antibody diversity. c. Class switching among constant-region genes.	**5**	CO3	K1, K2, K3, K4
	3.2 Clinical immunology a. Cytokines: properties; Receptors and Functions. b. Immunological tolerance. c. Hypersensitivity reactions: Classification and mechanisms. d. Autoimmunity: Pathogenesis; Classification (Organ-specific autoimmune disease and Systemic Autoimmune diseases). e. Immunodeficiencies: Primary and secondary immunodeficiencies. f. Transplantation immunology: Definition; Immunologic Basis of Graft Rejection; Allograft rejection; Clinical features of graft rejection; Graft v/s host reaction;	**10**	CO3	K1, K2, K3, K4, K5

	Immune tolerance to allograft; Immunosuppressive therapy for prevention of graft rejection.			
Module 4:	**4. Vaccines and Immunological techniques** **4.1 Concepts of vaccines** a. Whole-organism vaccines; recombinant vaccines; DNA and RNA vaccines; synthetic peptide and multivalent subunit vaccines.	**5**	CO4	K1,K2, K3 K4, K5
	4.2 Immunotechniques a. Antigen–antibody (Ag-Ab) reactions: General features of Ag-Ab reactions, Stages of Ag-Ab reactions (primary and secondary). b. Principles and techniques: in vitro precipitation; agglutination; immunofluorescence; ELISA; RIA; immunoelectrophoresis; immunodiffusion; Avidin-Biotin complex (ABC) method; Western blotting; Immunohistochemistry; flow cytometry	**10**	CO4	K1, K2, K3, K4, K5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. S. Stranford, J. Owen, J. Punt, J. Patricia, Kuby Immunology, Macmillan Learning, New York, 8th Ed., 2023. 2. P. J. Delves, S. J. Martin, D.R. Burton, I. M. Roitt, Roitt's Essential Immunology; Wiley Blackwell, Sussex; 13th Ed., 2017.			
References/ Readings:	1. A. Abbas, A. Lichtman, S. Pillai, Cellular and Molecular Immunology, Elsevier, Saunders, 8th Ed., 2014. 2. S. C. Parija, Textbook of Microbiology and Immunology; Elsevier; India, 2nd Ed. 2012. 3. F. C. Hay, O. M. R. Westwood, Practical Immunology; Cold spring Harbour, New York, 4th Ed., 2002.			

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Title of the Course	Clinical Biochemistry
Course Code	CHB-5007
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To introduce to safety measures and precautions in clinical laboratories. • To introduce knowledge on clinical investigations and analyses of clinical samples. • To understand the biochemistry of metabolic diseases/disorders of the human body. • To provide insights on biochemistry of ageing.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO1. explain the principles, safety measures, and biochemical basis of blood and serum analysis for clinical diagnosis.	PSO1, PSO2
	CO2. apply biochemical testing methods and interpretation principles to assess liver, kidney, thyroid, gastric, and pancreatic functions in clinical contexts.	PSO1, PSO2, PSO3
	CO3. analyze biochemical pathways and molecular mechanisms underlying metabolic	PSO1, PSO4, PSO5

	disorders and inborn errors of metabolism to interpret their clinical manifestations.			
	CO4. evaluate and integrate biochemical principles and ageing-related molecular changes to assess disease risk and potential interventions.		PSO1, PSO 3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Analysis of Clinical sample** **1.1 Blood sample** a. Collection and safety measures involved. b. Composition and function: Composition of blood, RBCs, Erythropoiesis, Hemoglobin, gas transport by hemoglobin, Blood buffer system (Henderson–Hasselbalch equation), acid-base balance and imbalance. c. Analysis: i. Hematological parameters: Hemoglobin, total cell count (TC), differential cell count (DC), erythrocyte sedimentation rate (ESR), bleeding time, clotting time. ii. Biochemical parameters: Glucose (fasting, postprandial, oral glucose tolerance test), lipid profile (total cholesterol, HDL, LDL, triglycerides), urea, blood gases (oxygen, carbon dioxide levels), pH.	**8**	CO1	K1, K2, K3
	1.2 Serum sample a. Collection methods and safety measures. b. Analysis: i. Proteins, albumin/globulin ratio ii. Bilirubin; creatinine; uric acid; electrolytes; iii. Enzymes of clinical and diagnostic importance: Enzymes as markers in the diagnosis of diseases; clinical significance of cholinesterase, alkaline and acid phosphatase (ALP and ACP), lactate dehydrogenase (LDH), creatine phosphokinase (CPK), aspartate aminotransferase (AST/SGOT), alanine aminotransferase (ALT/SGPT).	**7**	CO1	K1, K2, K3

Module 2:	**2. Clinical Laboratory diagnosis** **2.1 Liver function tests (LFTs)** a. Functions of the liver and liver profile in health and disease b. Bilirubin metabolism and its clinical significance c. Classification of LFTs and interpretation in diagnosis of liver diseases.	**5**	CO2	K1, K2, K3, K4
	2.2 Renal function test (RFTs) a. Urine: Composition of urine, collection and safety measures b. Kidney physiology: Urine formation, glomerular and tubular functions, water electrolyte balance. c. Analysis of urine: Physical, chemical and microscopic examination; interpretation of RFT results.	**5**	CO2	K1, K2, K3, K4
	2.3 Thyroid, Gastric and Pancreatic Function tests a. Thyroid function tests: serum free and total T3 & T4 and serum TSH) b. Gastric function tests: gastric analysis, hypo/achlorhydria and hyperacidity c. Tests to assess pancreatic function in disease.	**5**	CO2	K1, K2, K3, K4
Module 3:	**3. Metabolic disorders** **3.1 Disorders in metabolism** a. Carbohydrates: Regulation of blood glucose, insulin and diabetes mellitus (classification, stages and diagnosis); Hypoglycaemia; Diabetic ketoacidosis. b. Lipids: Hyperlipidaemias, clinical significance of cholesterol, hypercholesteremia, c. Heart: Cardiovascular disease (Atherosclerosis and Coronary artery disease), hypertension d. Proteins: Kwashiorkor, Marasmus Protein misfolding, Creutzfeldt-Jakob disease, mad cow disease, encephalopathy e. Blood Anaemia: Iron deficiency anemia, Megaloblastic anemia, Pernicious anemia, Sickle cell disease, hemolytic anemia f. Liver: Jaundice, cirrhosis	**8**	CO3	K1, K2, K3, K4

	g. Kidney: Diabetes insipidus, Renal calculi.			
	3.2 Inborn errors of metabolism a. Carbohydrate: Lactose intolerance, galactosemia, Glycogen storage disease. b. Lipids: Lysosomal storage disorders: Tay-Sach'sdisease; Gaucher's disease; Niemann Pick disease; Fabry's disease. c. Amino acids: Phenylketonuria, Albinism d. Purine/pyrimidine: Lesch-Nyhan Syndrome, Gout. e. Blood: Thalassemia f. Thyroid hormone: hyperthyroidism and hypothyroidism g. Skin: Xeroderma Pigmentosum	**7**	CO3	K1, K2, K3, K4
Module 4:	**4. Early Diagnostic Screening and Biochemistry of Ageing** **4.1 Early Diagnostic Screening** a. Prenatal diagnosis of diseases: Nuchal Translucency scan, Double marker blood, Non-invasive prenatal testing (NIPT). b. Newborn screening: Amniocentesis and chorionic villus sampling (CVS). c. Amniotic fluid and fetal blood examination. d. Acetylcholinesterase and other tests on amniotic fluid. e. Karyotyping, chromosomal abnormalities by cytogenetics.	**8**	CO4	K1, K2, K4 K4, K5
	4.2 Biochemistry of ageing a. Physiological and biochemical changes in ageing b. Biomarkers of ageing c. Ageing theories: Programmed theories and Error theories d. Epigenetics. e. Plasticity and regeneration. f. Anti-ageing approaches: stem cells and regeneration therapy.	**7**	CO4	K1, K2, K3, K4, K5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some			

	of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Texts:	1. D. M. Vasudevan, S. Sreekumari, K. Vaidyanathan, Textbook of Biochemistry for Medical students, Jaypee brothers Medical publishers; New Delhi, 6th Ed., 2011. 2. C. Smith, A. D. Mark, M. Lieberman, Marks' Basic Medical Biochemistry: A Clinical Approach; Lippincott's William and Wilkins, USA, 2nd Ed., 2004.
References/ Readings:	1. M. N. Chattergee, R. Shinde, R.; Textbook of Medical Biochemistry, Jaypee brothers Medical publishers Ltd., New Delhi, 8th Ed., 2012. 2. A. Gaw, R. A. Cowan, M. J. Murphy, D. S. J. O'Relly, R. Srivastava, Clinical Biochemistry, Elsevier; Canada, 5th Ed., 2013.

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Discipline Specific Elective (DSE) Courses

Title of the Course	Biochemistry Practical – III
Course Code	CHB-5203
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To develop practical skills in enzyme analysis including assays, kinetics and data interpretation. • To apply advanced analytical methods for biochemical sample analysis. • To perform antigen-antibody interactions for immunodiagnostics. • To analyze clinical samples for diagnosing metabolic and organ disorders.	
Course Outcomes:	The students will be able to:	**Mapped to PSO**
	CO1. isolate enzymes from living cells, purify and understand their substrate interactions and kinetics.	PSO1, PSO2, PSO3, PSO5
	CO2. develop methods for estimation of biomolecules and interpret spectral data to elucidate their structures.	PSO1, PSO2, PSO3, PSO4, PSO5

	CO3. analyse the antigen and antibody interactions for diagnosis of diseases and disorders.		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO4. assess clinical samples and interpret biochemical data for diagnosis and treatment of diseases.		PSO1, PSO2, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Concepts in Biochemistry (ANY SIX)** a. Screening of microbes for production of enzymes (amylases and cellulases). b. Assay of enzyme activity, rate of reaction of amylase c. Optimization of parameters for enzyme activity, amylase d. Determination of specific activity of enzyme, amylase e. Purification of enzyme by salting-out using ammonium sulphate. f. Dialysis of the precipitated enzyme. g. Purification of enzyme by Gel filtration. h. Determination of fold purification, percentage recovery of protein. i. Molecular weight determination of the enzyme by SDS PAGE. j. Determination of Km, Vmax.	**30**	CO1	K1, K2, K3, K4, K5
Module 2:	**2. Analytical Techniques in Biochemistry (ANY SIX)** a. Visualization of bacterial/fungal cells by Light microscopy and Phase contrast microscopy. b. Verification of Beer lambert law using BSA (Bovine serum albumin). c. Qualitative analysis of amino acids by ninhydrin/ Xanthoproteic/ isatin, Ehrlich's/ Hopkins-Cole/ lead sulphide/ sodium nitroprusside tests (Any three). d. Determination of extinction coefficient of Tryptophan/ Tyrosine (Any one). e. Demonstration of LC-MS and interpretation of data. f. Analysis of tryptophan/ tyrosine/ proline/ small organic molecules using IR	**30**	CO2	K1, K2, K3, K4, K5

	spectroscopy. g. Demonstration of NMR and interpretation of data. h. Elucidation of structure of cellular metabolites (e.g. polyphenols, coumarins, alkaloids, etc.) using IR, NMR and Mass profiles.			
Module 3:	**3. Concepts in Immunology** a. Agglutination assays. i. Determination of ABO and Rh blood group. ii. Latex bead agglutination: Rheumatoid Arthritis factor determination. b. Immunodiffusion assays. i. Single Immunodiffusion: Mancini technique. ii. Double Immunodiffusion: Ag-Ab pattern and Antibody titration: Ouchterlony procedure. c. Widal test: Slide and tube method. d. Rapid tests. i. Malarial antigens Pv/Pf. ii. Dengue IgM and IgG antibodies. e. ELISA: Dot-ELISA method. f. Immunoelectrophoresis: Counter Current Immunoelectrophoresis technique. g. Differential leukocyte count: Wright's and Giemsa's staining	**30**	CO3	K1, K2, K3, K4, K5
Module 4:	**4. Clinical Biochemistry (ANY SIX)** a. Analysis of blood i. Estimation of Haemoglobin (Hb) content of blood by copper sulphate method and Sahli's method. ii. Estimation of total cell (TC) counts of blood sample. b. Estimation of blood glucose by glucose oxidase method or Folin-Wu method. c. Estimation of blood cholesterol level by Liberman Burchard reaction.	**30**	CO4	K1, K2, K3, K4, K5

	d. Estimation of serum bilirubin level by Malloy and Evelyn method e. Analysis of urine: i. Physical examination: assessment of volume, appearance, odour, color, pH and specific gravity ii. Microscopic examination: assessment of crystals, casts, cells in urine sample. Chemical examination of urine: i. Estimation of glucose in urine sample by Benedict's method. ii. Estimation of albumin content in urine sample by Sulfosalicylic acid method. f. Estimation of blood urea by Diacetyl-monoxime method. g. Estimation of serum creatinine by Jaffe's method.			
Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.			
Texts:	1. K. Wilson, J. Walker; Principles and Techniques of Practical Biochemistry; Cambridge University Press; New York, 7th Ed., 2010. 2. S. K. Sawhney, R. Singh; Introductory Practical Biochemistry; Narosa Publishing House; New Delhi, India, 2nd Ed., 2005.			
References/ Readings:	1. S. Mohanty, Practical clinical Biochemistry, Jaypee Brothers Medical Publishers, New Delhi, India, 1st Ed., 2013. 2. J. Kenkel, Analytical Chemistry for Technicians, Lewis publishers, USA, 3rd Ed., 2002. 3. G. Damodaran, Practical Biochemistry, Jaypee Brothers Medical Publishers, New Delhi, India, 2nd Ed., 2011. 4. H. Prescott, Laboratory exercise in Microbiology, MacGraw-Hill Companies, New York, USA, 5th Ed, 2002. 5. W. Kemp, Organic Spectroscopy, Palgrave Macmillan, New York, 1991.			

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Title of the Course	Biochemistry Practical – IV
Course Code	CHB-5204
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To develop practical skills in enzyme analysis including assays, kinetics and data interpretation. • To apply advanced analytical methods for biochemical sample analysis. • To perform antigen-antibody interactions for immunodiagnostics. • To analyze clinical samples for diagnosing metabolic and organ disorders.	
Course Outcomes:	The students will be able to	**Mapped to PSO**
	CO 1. isolate enzymes from living cells, purify and understand their substrate interactions and kinetics.	PSO1, PSO2, PSO3, PSO5
	CO 2. develop methods for estimation of biomolecules and interpret spectral data to elucidate	PSO1, PSO2,

	their structures.		PSO3, PSO4, PSO5	
	CO 3. analyse the antigen and antibody interactions for diagnosis of diseases and disorders.		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 4. examine clinical samples and interpret biochemical data for diagnosis and treatment of diseases.		PSO1, PSO2, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Concepts in Biochemistry (ANY SIX)** a. Screening of microbes for production of enzymes tannases, proteases b. Assay of enzyme activity, rate of reaction of cellulases/ Xylanases c. Optimization of parameters for enzyme activity of cellulases/ Xylanases d. Determination of specific activity of enzyme of cellulases/ Xylanases e. Purification of enzyme by salting-out using ammonium sulphate. f. Dialysis of the precipitated enzyme. g. Purification of enzyme by Gel filtration. h. Determination of fold purification, percentage recovery of protein. i. Molecular weight determination of the enzyme by SDS PAGE. j. Determination of Km, Vmax.	**30**	CO1	K1, K2, K3, K4, K5
Module 2:	**2. Analytical Techniques in Biochemistry (ANY SIX)** a. Identification of morphology of microorganisms using monochrome staining techniques. b. Identification of morphological features of fungal species using light microscopy. c. Determination of extinction coefficient of Arginine/ Cysteine (Any one).	**30**	CO2	K1, K2, K3, K4, K5

	d. GC Analysis of essential oils like lemon grass/ lavender/ clove/ sandalwood oils (Any two). e. Analysis of nucleic acids using IR spectroscopy. f. Structure elucidation of plant polyphenols using NMR spectroscopy. g. Elucidation of structure of cellular metabolites (e.g. flavanoids, quinones, carotenoids, etc.) using combined IR, NMR and Mass profiles.			
Module 3:	**3. Concepts in Immunology (ANY SIX)** a. Agglutination assays. i. Coomb's test. ii. Latex bead agglutination: C-reactive protein determination. b. Immunodiffusion assays. i. Single Immunodiffusion: Oudin procedure. ii. Double Immunodiffusion: Oakley–Fulthrope procedure. c. VDRL test d. Rapid tests. i. COVID-19 rapid antigen tests. ii. HBsAg rapid test. e. ELISA: Antibody sandwich ELISA method. f. Immunoelectrophoresis: Rocket Immunoelectrophoresis technique. g. Differential leukocyte count: Leishman's staining	**30**	CO3	K1, K2, K3, K4, K5
Module 4:	**4. Clinical Biochemistry (ANY SIX)** a. Analysis of blood: i. Estimation of Haemoglobin (Hb) content of blood by Cyanmethemoglobin	**30**	CO4	K1, K2, K3, K4, K5

	method and Alkaline hematin method. ii. Estimation of clotting time of blood by Lee and White method. b. Estimation of blood glucose by o-Toluidine method. c. Estimation of blood cholesterol level by Cholesterol Oxidase Method. d. Estimation of serum alanine transaminase (SGPT) and aspartate transaminase (SGOT) by Reitman and Frankel method. e. Chemical examination of urine: i. Evaluation of chloride, calcium, sulphates, phosphorus, ammonia, urea and uric acid in urine. ii. Evaluation of ketone bodies in urine sample. f. Estimation of blood urea by Alkaline hypobromite method. g. Estimation of serum uric acid by Caraway method.			
Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.			
Texts:	1. K. Wilson, J. Walker; Principles and Techniques of Practical Biochemistry; Cambridge University Press; New York, 7th Ed., 2010. 2. S. K. Sawhney, R. Singh; Introductory Practical Biochemistry; Narosa Publishing House; New Delhi, India, 2nd Ed., 2005.			
References/ Readings:	1. S. Mohanty, Practical clinical Biochemistry, Jaypee Brothers Medical Publishers, New Delhi, India, 1st Ed., 2013. 2. J. Kenkel, Analytical Chemistry for Technicians, Lewis publishers, USA, 3rd Ed., 2002. 3. G. Damodaran, Practical Biochemistry, Jaypee Brothers Medical Publishers, New Delhi, India, 2nd Ed., 2011. 4. H. Prescott, Laboratory exercise in Microbiology, MacGraw-Hill Companies, New York, USA, 5th Ed, 2002. 5. W. Kemp, Organic Spectroscopy, Palgrave Macmillan, New York, 1991.			

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SEMESTER III

Research Specific Elective (RSE) Courses

Title of the Course	Biochemistry Practical -V
Course Code	CHB-6000
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	NO
Course for advanced learners	NO

Pre-requisites for the Course:	Nil
Course Objectives:	• To administer skills on key microbial fermentation processes and product monitoring in industrial biochemistry. • To acquire experimental knowledge on sampling environmental samples and monitoring environmental pollution. • To develop hands-on experience on techniques involving recombinant DNA technology. • To develop expertise in identifying bacterial genera based on morphological and biochemical characterization techniques. • To equip with skills in research design, literature review, referencing tools, and fundamental biostatistical analysis.

Course Outcomes: **Course Outcomes:**	Students will be able to:		**Mapped to PSO**	
	perform fermentation processes and monitor product formation.		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 1. apply techniques for qualitative and quantitative estimation of environmental samples.		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 2. choose the appropriate technique for gene manipulation and recombinant DNA technology		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 3. identify and classify bacteria based on morphological and biochemical characterization techniques		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 4. formulate research problems, review literature, and apply statistical methods in research.		PSO1, PSO2, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Industrial biochemistry** a. Production of wine and monitoring of sugar reduction during the fermentation. b. Production of wine and monitoring of alcohol production during fermentation. c. Production of vinegar and estimation of acetic acid. d. Study of fermentation process of milk to curd by microscopic observation and monitoring of pH. e. Study fermentation of dosa batter and monitor pH and microbial load in given dosa batter samples. f. Immobilization of enzymes (α-amylase - EC 3.2.1.1; Fungal Diastase ex. *Aspergillus oryzae* /Lipase – EC 3.1.1.3; ex. *Aspergillus* sp.) and comparative study of free and immobilized enzymes activity.	**24**	CO1	K1, K2, K3, K4, K5
Module 2:	**2. Environmental pollution** a. Estimation of Dissolved oxygen (DO) in polluted water.	**20**	CO2	K1, K2, K3, K4, K5

	b. Determination of biochemical oxygen demand of given water sample using Winkler method. c. Estimation of Chemical Oxygen Demands (COD) of water sample. d. Detection of coliforms in water samples by MPN test. e. Estimation of nitrite in water samples by colorimetry (diazotization method).			
Module 3:	**3. Genetic engineering** a. Digestion of plasmid (pBR322) and construction of Recombinant DNA molecule by ligation. b. Preparation of competent *E. coli* cells. c. Transformation of competent cells with recombinant plasmid. d. Screening and confirmation of recombinant transformants e. Amplification and verification of insert by Polymerase chain reaction (PCR). f. Determination of G+C% and melting temperature of DNA sample.	**28**	CO3	K1, K2, K3, K4, K5
Module 4:	**4. Bacterial identification methods based on biochemical characteristics** a. Carbohydrates fermentation test. b. IMViC test c. Catalase test d. Starch hydrolysis test e. Lipid hydrolysis test f. Gelatin hydrolysis test g. Coagulase test h. Oxidase test i. Motility test by hanging drop technique j. Urease test k. Nitrate reduction test l. Triple sugar iron test	**32**	CO4	K1, K2, K3, K4, K5, K6
Module 5	**5. Research methodology and biostatistics**	**16**	CO5	K1, K2,

	a. Identification and Formulation of a Research Problem b. Selection and preparation of Research Design c. Conducting a Structured Literature Review Using Online Databases (PubMed, Scopus, Google Scholar) d. Referencing and citations using softwares (Mendeley/Zotero/ Endnote) e. Spreadsheet - data handling, processing, analysis and graph preparation. f. Developing understanding for linear equation analysis (regression analysis). g. Frequency distribution and calculation of descriptive measures -mean, median, mode, variance, standard deviation and standard error. h. To study normal distribution curve with examples i. To carry out Hypothesis testing using Z-test and Student t-test. j. One way ANOVA and Chi-Square test with examples. k. Application of statistical software (SPSS/Sigmaplot/Systat) for analysis.			K3, K4, K5, K6
Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.			
Texts:	1. J.P. Harley, Prescott, L.M.., Laboratory exercises in Microbiology; The McGraw Hill Companies Inc., USA., 5th Ed, 2002. 2. K.R. Aneja, Experiments In Microbiology, Plant pathology and Biotechnology, New Age International Pvt. Ltd., New Delhi, India, 6th Ed., 2023. 3. J.K. Setlow, Genetic Engineering: Principles and Methods, Springer; New York, 2nd Ed., 2011. 4. C.R. Kothari, G. Garg, Research Methodology: Methods and Techniques; New Age International Publishers, New Delhi, 3rd Ed., 2014.			
References/ Readings:	**1.** R. Kumar, Research Methodology: A Step-by-Step Guide for Beginners; SAGE Publications, New Delhi, 4th Ed., 2014 **2.** L.E. Cassida, Industrial microbiology. New Age International Pvt Ltd Publishers, Delhi, 2nd Ed., 2019. **3.** M.C. Flickinger, S.W. Drew (Ed). Encyclopedia of bioprocess technology, Wiley Blackwell, New Jersey, Volumes 1 – 5 Ed. 1999. **4.** M.D. Trevan, Immobilized enzymes: An introduction & application in Biotechnology; Wiley Blackwell, New Jersey, 1st Ed., 1980.			

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Title of the Course	Biochemistry Practical -VI
Course Code	CHB-6001
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	NO
Course for advanced learners	NO

Pre-requisites for the Course:	Nil	
Course Objectives:	• To administer skills on key microbial fermentation processes and product monitoring in industrial biochemistry. • To acquire experimental knowledge on sampling environmental samples and monitoring environmental pollution. • To develop hands-on experience on techniques involving recombinant DNA technology. • To develop expertise in identifying bacterial genera based on morphological and biochemical characterization techniques. • To equip with skills in research design, literature review, referencing tools, and fundamental biostatistical analysis.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. perform fermentation processes, monitor product formation.	PSO1, PSO2, PSO3, PSO4, PSO5

	CO 2. apply different techniques for qualitative and quantitative estimation of environmental samples.		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 3. choose the appropriate method for gene manipulation and recombinant DNA technology		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 4. identify and classify bacteria based on morphological and biochemical characterization techniques		PSO1, PSO2, PSO*3*, PSO*4*, PSO5	
	CO 5. formulate studies, review literature, and apply statistical methods in research.		PSO1, PSO2, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Industrial biochemistry** a. Production of citric acid and its monitoring during the fermentation. b. To perform comparative study of rheology of substrate solutions and fermentation broth (any Indian fermentation products (Idli/ dosa) c. Immobilization of enzymes (α-amylase - EC 3.2.1.1; Fungal Diastase ex. *Aspergillus oryzae* /Lipase – EC 3.1.1.3; ex. *Aspergillus* sp.) using calcium alginate, DEAE-cellulose and TiO_2 and determination of its activity. d. Isolation and microscopic examination of Lactic acid bacteria from curd sample. e. Production of ethanol using agro- industrial waste and its monitoring. f. Monitoring of alcohol production by GC.	**24**	CO1	K1, K2, K3, K4, K5
Module 2:	**2. Environmental pollution** a. Estimation of phosphorous in water sample. b. Determination of alkalinity of surface, ground and sea water sample using titrimetric analysis c. Determination of acidity of surface, ground and sea water sample using titrimetric analysis d. Detection of sewage pollution by screening for indicator organisms: *Enterococcus*	**20**	CO2	K1, K2, K3, K4, K5

	faecalis. e. Estimation of nitrite in water sample by titrimetric (diazotization) method			
Module 3:	**3. Genetic engineering** a. Digestion of plasmid (pUC18) and construction of Recombinant DNA molecule by ligation. b. Preparation of competent E. coli cells. c. Transformation of competent cells with recombinant plasmid. d. Screening and confirmation of recombinant transformants. e. Amplification and verification of insert by Polymerase chain reaction (PCR). f. Determination of G+C% and melting temperature of DNA sample.	**28**	CO3	K1, K2, K3, K4, K5, K6
Module 4:	**4. Fungal identification methods** a. Slide culture technique for studying the morphology of molds. b. Measurement of fungal conidia by the use of a counting chamber. c. Preliminary identification of fungi based on staining techniques: i. Grocott-Gomori Methenamine Silver (GMS) staining ii. Negative staining d. Identification of yeasts based on biochemical characteristics: i. Carbohydrate assimilation test. ii. Germ tube test iii. Chromogenic agar test iv. Urease test	**32**	CO4	K1, K2, K3, K4, K5, K6
Module 5:	**5. Research methodology and biostatistics** a. Preparation and writing of an abstract b. Preparation of a Research Proposal c. Graphical representation of Results d. Preparation and Presentation of a Research Paper	**16**	CO5	K1, K2, K3, K4, K5, K6

	e. Preparation and Presentation of a Poster f. Data handling, management, and analysis using spreadsheet software g. Developing understanding for linear equation analysis (regression analysis). h. Formation of frequency distribution and calculation of descriptive measures-mean, median, mode, variance, standard deviation and standard error. i. To study normal distribution curve with example j. To carry out Hypothesis testing using Z-test and t-test k. One way ANOVA and Chi-Square test l. Use of statistical software packages for analysis and data interpretation.			
Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.			
Texts:	1. J.P. Harley, Prescott, L.M.., Laboratory exercises in Microbiology; The McGraw Hill companies Inc., USA., 5th Ed, 2002. 2. K.R. Aneja, Experiments In Microbiology, Plant pathology and Biotechnology, New Age International Pvt. Ltd., New Delhi, India, 6th Ed., 2023. 3. J.K. Setlow, Genetic Engineering: Principles and Methods, Springer; New York, 2nd Ed., 2011. 4. C.R. Kothari, G. Garg, Research Methodology: Methods and Techniques; New Age International Publishers, New Delhi, 3rd Ed., 2014.			
References/ Readings:	1. R. Kumar, Research Methodology: A Step-by-Step Guide for Beginners; SAGE Publications, New Delhi, 4th Ed., 2014 2. L.E. Cassida, Industrial microbiology. New Age International Pvt Ltd Publishers, Delhi, 2nd Ed., 2019. 3. M.C. Flickinger, S.W. Drew (Ed). Encyclopedia of bioprocess technology, Wiley Blackwell, New Jersey, Volumes 1 – 5 Ed. 1999. 4. M.D. Trevan, Immobilized enzymes: An introduction & application in Biotechnology; Wiley Blackwell, New Jersey, 1st Ed., 1980.			

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Title of the Course	Industrial Biochemistry	
Course Code	CHB-6002	
Number of Credits	4	
Theory/Practical	Theory	
Level	500	
Effective from AY	2026-27	
New Course	No	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	

Pre-requisites for the Course:	Nil	
Course Objectives:	• To acquire fundamental concepts and techniques of fermentation and bioreactor operation, including types of fermentation and fermenters. • To learn the role of industrial microorganisms and strain improvement methods used in food technology and fermentation industries. • To explore the industrial production processes of biochemically important products such as enzymes, carbohydrates, lipids, and immobilized biocatalysts. • To understand the production of pharmaceuticals, nutraceuticals, and microbial fermentation products on an industrial scale.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**

	CO 1. describe different fermentation processes, fermenter types, and the critical parameters influencing industrial fermentation.		PSO1	
	CO 2. identify and explain the applications of microorganisms in food technology and the industrial production of fermented foods and beverages.		PSO3	
	CO 3. analyze the production methods of key industrial biochemicals including enzymes, carbohydrates, lipids, and immobilized biocatalysts.		PSO5	
	CO 4. evaluate and apply knowledge of microbial production of pharmaceuticals, nutraceuticals, and other fermentation-derived products for industrial use		PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Fermentation and bioreactors** a. Introduction to Fermentation: Industrial fermentation and its range, advantages of industrial fermentations over chemical manufacturing process, types of fermentation processes: submerged and solid-state fermentation, modes of fermentation: batch, fed-batch and continuous, microbial growth curve and its use in designing modes of fermentation b. Fermenters: Basic components of a fermenter, types of fermenters with their advantages and disadvantages, solid state fermentation, anaerobic fermentation. c. Significance and control of various fermentation parameters: Maintenance of aseptic conditions, methods of sterilisation, aeration and agitation, Industrial media and the nutrition of industrial organisms, scale up and scale down of a fermentation process, rheological properties of fermenter, Online and offline monitoring, computerization of fermenter operation. d. Downstream processing: Steps of downstream processing: Details of removal of insolubles, disruption of cell, isolation/extraction/purification, recovery and final product isolation of fermentation products	**15**	CO1	K1, K2
Module 2:	**2.1 Food technology**	**15**	CO2	K1, K2,

	a. Characteristics of industrial microorganisms; strain improvement; use of auxotrophic mutants; cultivation of microorganisms b. Introduction to processed foods: Introduction about different food industries, general properties and microorganisms involved in it c. Industrial production of few food products: i. Production of foods made from milk: Cheese, Probiotics – yoghurt/ curd. ii. Production of alcohol-based fermentation products: wine, beer, vinegar. iii. Production of oriental fermented foods: Soy sauce, tofu, tempeh. iv. Production of Indian fermented foods: Idli, dosa, dokhla. v. Production of ethnic fermented foods and beverages of Goa			K3, K4
module 3	**3.1 Industrial production of biochemically important products** a. Production of industrially important proteins. i. Industrially important enzymes - amylase / protease / pectinase / lipase b. Production of industrially important carbohydrates. ii. Manufacturing and refining of cane sugar, pectin/cellulose iii. Manufacturing of polysaccharides: plant polysaccharide (Gum Arabic), microbial polysaccharides, modified carbohydrates: modified starches, modified cellulose c. Production of industrially important lipids. i. Extraction and refining of vegetable oils and animal fats in general. ii. Extraction and applications of chlorophyll, carotene, lycopene, curcumin, and essential oils.	**10**	CO3, CO4	K1, K2, K3, K4
	3.2 Immobilized Biocatalysts: **Enzymes and Cells** a. Rationale for immobilizing enzymes and whole cells. b. Methods for enzyme and whole cell immobilization, supports and their selection. c. Properties of immobilized biocatalysts. d. Industrial applications of immobilized biocatalysts.	**5**	CO3, CO4	K1, K2, K3, K4, K5
Module 4	**4.1 Production of pharmaceuticals, nutraceuticals and biochemicals**	**10**	CO3,	K1, K2,

	a. Production of antibiotics: penicillins/ streptomycins b. Production of vitamins: B12/ascorbic acid c. Production of amino acids: lysine/glutamine d. Production of alcohol: ethanol e. Production of organic acid: citric acid/ lactic acid		CO4	K3, K4
	4.2 Microbial cells as fermentation products a. Production of Baker's yeast b. Single cell proteins/Spirulina c. Bacterial insecticides d. Mushrooms	**5**	CO3, CO4	K1, K2, K3, K4, K5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. D. L. Nelson, M. M. Cox, Lehninger: Principles of Biochemistry, W.H.Freeman and Co. Ltd.; New York, 7th Ed., 2017. 2. N. Okafor, Modern Industrial Microbiology and Biotechnology, Science Publishers, Florida, USA, 4th Ed., 2007. 3. L. E. Casida, JR.; Industrial Microbiology, New Age International Publishers New Delhi, India, 2nd Ed., 2019.			
References/ Readings:	1. W. Clarke, Biotechnology: Industrial Microbiology a Textbook, CBS Publishers and distributers New Delhi, India, 1st Ed., 2016. 2. J. P. Tamang, Ethnic Fermented Foods and Beverages of India: Science History and Culture. Springer Nature New York City, 1st Ed., 2020. 3. W. C. Frazier, D. C. Westhoff, Food Microbiology –Tata McGraw Hill Publishers, Ohio, U.S., 5th Ed., 2017. 4. P. F. Stanbury, A. Whitakar, S. Hall, Principles of fermentation technology, Butterworth-Heinemann Massachusetts, USA, 2nd Ed., 1995, 5. A. Kuila, V. Sharma, Principles and Applications of Fermentation Technology, Wiley-Scrivener Publishing, New Jersey, 1st Ed., 2019.			

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Title of the Course	Genetic engineering
Course Code	CHB-6003
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To understand the fundamental principles and tools of genetic engineering. • To develop knowledge of vector systems and gene transfer methods for both prokaryotic and eukaryotic cells • To gain theoretical proficiency in gene cloning and analysis techniques. • To explore the applications of recombinant DNA technology in biotechnology, medicine, agriculture, and forensic science.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. explain the historical development of molecular biology and biotechnology, and describe the roles of enzymes, cloning vectors, and Polymerase Chain Reaction (PCR) techniques in genetic manipulation.	PSO 1, PSO 2
	CO 2. apply knowledge of vector systems and gene transfer methods for both prokaryotic and	PSO 1

	eukaryotic cells.			
	CO 3. demonstrate theoretical proficiency in gene cloning and analytical techniques, including the construction and screening of genomic and cDNA libraries, DNA sequencing methods, mutagenesis, and analysis of DNA–protein interactions.		PSO 1, PSO 2, PSO 3	
	CO 4. evaluate and interpret the applications of recombinant DNA technology in diverse fields such as biotechnology, medicine, agriculture, and forensic science.		PSO 1, PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Fundamentals of Genetic Engineering** a. History of Genetic engineering b. Principles of Gene cloning c. Significance of Gene cloning in Molecular biology and Biotechnology. d. Enzymes used in rDNA technology (Restriction enzymes, nucleases, RNA polymerases, DNA polymerases, PNK, alkaline phosphatases, DNA ligases). Cloning Vectors for *E. coli*: Plasmids, Bacteriophage λ, Filamentous phage, Cosmids, Phagemids and other advanced vectors: BAC, YAC, P1-derived Artificial Chromosome, Shuttle vectors, Expression vectors. e. Polymerase chain reaction: Principles of PCR, primer designing, components of PCR reactions, Properties of DNA polymerases, Different types of PCR (multiplex, nested, touchdown, hotstart, quantitative PCR) .	**15**	CO1	K1, K2, K3
Module 2:	**2. Cloning Vectors for Eukaryotes** a. Vectors for cloning in yeast, Vectors for cloning in animal cells– adenoviral vector, adeno-associated viral vectors, retroviral vectors, baculovirus vectors for cloning in insect cells. b. Ligation of DNA fragments– using DNA ligases, homopolymer tailing, linkers and adaptors. c. Introduction of foreign DNA into prokaryotes - Natural gene transfer methods, calcium chloride mediated transformation, transfection with phage vectors.	**15**	CO2	K1, K2, K3

	d. Introduction of foreign DNA into animal cells - lipofection, electroporation, microinjection, microprojectile.			
Module 3	**3. Gene Cloning and Manipulation techniques** a. Construction of genomic and cDNA libraries. b. Selection and screening of recombinant clones: Methods based on nucleic acid hybridization, finding specific clones by functional complementation. Reporter genes. Studying protein-protein interactions-Phage display libraries, yeast two hybrid systems. c. DNA sequencing methods –Sanger's sequencing method, Next generation sequencing methods– pyrosequencing, Polony sequencing. altering genes, Site-directed mutagenesis, DNA microarrays. d. Dot Blot and Slot Blot Hybridization, Fluorescence insitu hybridization. Analysis of DNA protein interactions-Electrophoretic mobility shift assay, Filterbinding assay, Chromatin Immunoprecipitation (ChIP) assay, Methylation Interference assay.	**15**	CO3	K1, K2, K3, K4
Module 4	**4.1 Applications of Recombinant DNA Technology** a. Biotechnological applications: hormones, vaccines, therapeutic proteins (antibodies, clotting factors). b. Diagnostic and forensic applications: Molecular marker technique including RFLP, AFLP, RAPD, SSR, VNTR, SNP. c. Agricultural applications: genetically engineered insecticidal plants,herbicide resistant plants, genetically modified plants. **4.2 Expression of Engineered Proteins** a. Engineering microbes for the production of therapeutic proteins - insulin and growth hormones. b. Concepts of gene knock out technique- Cre-loxP recombination. Production of transgenic mice and applications of transgenic mice. c. Gene Therapy: Gene silencing by RNA interference technology, Genome editing by CRISPR/Cas.	**15**	CO4	K1, K2, K3, K4, K5

Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Texts:	1. T.A. Brown, Gene cloning and DNA analysis. Wiley-Blackwell, Hoboken, 8th Ed., 2020. 2. S.B. Primrose & R.M. Twyman, Principles of gene manipulation and genomics. Wiley-Blackwell, Hoboken, 7th Ed., 2013. 3. B.A. Pierce, Genetics: A conceptual approach. W.H. Freeman and Company, New York, 6th Ed., 2017. 4. A.J.F. Griffiths, S.R. Wessler, R.C. Lewontin, W.M. Gelbart, D.T. Suzuki & J.H. Miller, Introduction to genetic analysis. W.H. Freeman and Company, New York, 9th Ed., 2008.
References/ Readings:	1. J.E. Krebs, E.S. Goldstein & S.T. Kilpatrick, Lewin's GENES XII. Jones & Bartlett Learning, Burlington, 2017. 2. D.L. Hartl & E.W. Jones, Genetics: Analysis of Genes and Genomes. Jones & Bartlett Publishers, Boston, 7th Ed., 2009.
Web Resources:	1. https://books.google.co.in/books?hl=en&lr=&id=5SusEAAAQBAJ&oi=fnd&pg=PR15&dq=Genetic+Engineering++&ots=p60yGJMHXS&sig=B3yO443ScDqw8CwnUPvLrTrex1k#v=onepage&q&f=false

Title of the Course	Microbes in health and diseases
Course Code	CHB-6004
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	NO
Bridge Course/ Value added Course	NO
Course for advanced learners	NO

Pre-requisites for the Course:	Nil	
Course Objectives:	• To understand the scope of medical microbiology and to provide insights on the microbial control measures, and specimen handling, transport and identification in clinical laboratories. • To develop an understanding on role of microbiota for human health and development of bacterial diseases. • To gain knowledge on the diseases caused by fungi, protozoa and viruses and their pathophysiology. • To comprehend the mechanisms of action of antimicrobial drugs against pathogens, development of drug resistance, and strategies to combat drug resistance.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. apply the knowledge of microbial control measures; specimen handling and identifying microorganisms in a microbiological or clinical laboratory.	PSO1, PSO2, PSO4, PSO5
	CO 2. explain the role of microbiota in human health and diseased conditions.	PSO1, PSO4

	CO 3. illustrate the pathogenesis and pathophysiology of fungal, protozoan and viral diseases in humans.		PSO1, PSO 4, PSO 5	
	CO 4. identify the microbial target sites for treating bacterial, fungal, viral and protozoan diseases and develop strategies for overcoming drug resistance in pathogens.		PSO 1, PSO2, PSO3, PSO 4, PSO 5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Microbiology, microbial control measures, clinical microbiology** **1.1 Scope of microbiology:** a. Classification of microorganisms b. discovery of microorganisms c. Koch's postulates d. Scope and future of Microbiology	**4**	CO1	K1, K2, K3
	1.2 Control of microorganisms a. Safety in microbiological laboratory b. Microbial control methods: i. Frequently used terms in microbial control: Definitions and types ii. Physical control methods iii. Chemical control method iv. Mechanical removal methods c. Factors influencing the effectiveness of antimicrobial agents d. Evaluation of effectiveness of antimicrobial agents	**6**	CO1	K1, K2, K3
	1.3 Clinical microbiology a. Specimens: Collection, handling and transport b. Identification of microorganisms from specimens: microscopy, growth and biochemical characteristics, rapid methods of identification, bacteriophage typing and Molecular methods and analysis of metabolic Products.	**5**	CO1	K1, K2, K3,

Module 2:	**2.1 Human normal flora** a. Symbiotic interactions: Definitions, types and examples (endo- and ecto-symbionts, consortium, Mutualism, Cooperation, Commensalism, Predation, Parasitism, Ammensalism, Competition) b. Human microbe interactions: Human microbiota c. Gnotobiotic microorganisms d. Distribution of microbiota in human body e. Human microbiota in health: functions, microbe-host interaction, health benefits of Skin, Respiratory, Oral, Gut, Genitourinary microbiota	**7**	CO2	K1, K2, K3, K4
	2.2 Human microbiota in diseases: a. Opportunistic infections and Nosocomial infections b. Human microbiota and bacterial infections**:** i. Bacterial pathogenesis and toxigenicity ii. Host defence against microbial invasion and microbial mechanisms for escaping host defences iii. Bacterial infections: Gastroenteric (*Clostridium difficile*; *Helicobacter pylori*; *Escherichia coli*); Skin (*Staphylococcal*); Respiratory (Streptococcal, Pneumococcal); Urogenital tract (UTIs, Bacterial vaginosis); Oral cavity (Dental caries, Periodontitis). iv. Bacterial secondary infections: associated with HIV and Influenza. v. Human microbiota and metabolic disorders: Irritable bowel disease; Obesity; Type 2 diabetes mellitus; Allergic diseases; Liver diseases.	**8**	CO2	K1, K2, K3, K4
Module 3:	**3. Fungal, parasitic and viral infections 3.1 Fungal infections:** a. Superficial mycoses: b. Cutaneous and sun-cutaneous mycoses: Epidermophyton, Microsporum and Trichophyton infections c. Systemic mycoses: Cryptococcosis, Blastomycosis, Coccidioidomycosis,	**3**	CO3	K1, K2, K3, K4

	Histoplasmosis d. Opportunistic mycoses: Aspergillosis, Candidiasis, Microsporidia, Pneumocystis Pneumonia			
	3.2 Parasitic infections a. Introduction to parasites b. Arthropod borne diseases: Malaria, Leishmaniasis, Trypanosomiasis c. Food and water-borne diseases: Amebiasis, Giardiasis, Ascariasis	**3**	CO3	K1, K2, K3, K4
	3.3 Viral infections: a. Viruses: i. Introduction to viruses and virology ii. General properties of viruses iii. Structure and organization of viruses iv. Viruses of bacteria and archaea v. Eukaryotic viruses: Taxonomy of animal DNA and RNA viruses; Reproduction of vertebrate viruses: Adsorption of Virions, penetration and uncoating, Genome replication and transcription in DNA Viruses, Genome replication, transcription, and protein synthesis in RNA viruses, Assembly of virus capsids and virions release; Cytocidal infections and cell damage vi. Viruses and cancer b. Viral infections: i. Pathogenesis of viral diseases ii. Viral diseases: HIV, Influenza, Poliomyelitis, Dengue fever, Chikungunya, Hepatitis, Rabies	**9**	CO3	K1, K2, K3, K4
Module 4:	**4. Antimicrobial therapy** **4.1 Antimicrobial chemotherapy:** a. Development of chemotherapy b. General characteristics of antimicrobial drugs	**10**	CO4	K1, K2, K3, K4, K5

	c. Tests for determining antimicrobial activity: Dilution Susceptibility Tests, Diffusion tests, Etest. d. Classification, mechanism of action and drug resistance of: antibacterial drugs, antifungal drugs, antiviral drugs, antiprotozoan drugs			
	4.2 Alternate strategies for overcoming antimicrobial resistance: a. Probiotics: Introduction, sources of probiotic microorganisms, selection criteria for probiotic microbes, mechanism of action, health benefits b. Antimicrobial peptides: Introduction, classification, mechanism of action and applications.	**5**	CO4	K1, K2, K3, K4, K5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. G.J. Tortora, B.R. Funke, C.L. Case, Microbiology: An Introduction, Pearson Benjamin Cummings publishers; United states, 10th Ed., 2010. 2. J. Willey, K. Sandman, D. Wood, Prescott's Microbiology, Mc Graw Hill, New York, 11th Ed., 2020. 3. M.J. Pelczar, E.C.S. Chan, R. N. Krieg, Pelczar Microbiology, Tata McGraw-Hill Publishing Company Limited, India, 5th Ed., 2023. 4. C.K.J. Panniker, Anantnanrayan and Paniker's Textbook of Microbiology, Orinet Longman Pvt. Ltd., Chennai, India, 7th Ed., 2005.			
References/ Readings:	1. S.C. Parija, Textbook of Microbiology and Immunology, Elsevier, India, 2nd Ed., 2012. 2. R.A. Harvey, C.N. Cornelissen, B.D. Fisher, B, Lippincott's Illustrated review: Microbiology., 3rd Ed, Lippincott's William and Wilkins, Philadelphia, Pennsylvania 2007. 3. D. Haller, The gut microbiome in health and disease. Springer International publishing., Germany, 1st Ed., 2018.			
Web Resources:	https://doi.org/10.3389/fmicb.2018.00151			

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Title of the Course	Research Methodology in Biochemistry
Course Code	CHB-6005
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	YES
Bridge Course/ Value added Course	NO
Course for advanced learners	No

Pre-requisites for the Course:	Nil
Course Objectives:	• To develop an understanding of research principles and processes, including identification of research problems and formulation of hypotheses. • To select essential ethical principles and core laboratory safety practices required for responsible and safe scientific work. • To equip with skills in research design, data collection, and analysis for scientific inquiry and experimentation. • To enhance the ability to review literature critically and communicate research effectively through scientific writing, reports, and proposals. • To understand the characteristics of biological data, sources of errors, and methods for accurate data handling and graphical representation in biological research.

Course Outcomes:	Students will be able to:		**Mapped to PSO**	
	CO 1. identify and define research problems, formulate hypotheses, and outline research objectives.		PSO2	
	CO 2. apply ethical reasoning and choose fundamental laboratory safety procedures in academic or research settings.		PSO3	
	CO 3. design appropriate methodologies and apply analytical techniques for data collection and interpretation.		PSO3	
	CO 4. conduct critical literature reviews and prepare well-structured research reports, manuscripts, and proposals.		PSO3	
	CO 5. corelate the characteristics of biological data, sources of errors, and methods for accurate data handling and graphical representation in biological research.		PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Concepts of research and hypothesis development** a. Introduction to research and scientific inquiry b. Types and characteristics of research (basic, applied, quantitative, qualitative, etc.) c. Identifying research problems and formulating research questions d. Development of research hypothesis: Definition and characteristics of a good hypothesis, types of hypotheses (null, alternative, directional, non-directional), relationship between variables and hypothesis testing.	**8**	CO 1, CO 3	K1, K2, K3
	1.2 Review of Literature a. Purpose and importance b. Sources of literature (primary, secondary, tertiary) c. Steps in conducting a literature review d. Organizing and synthesizing literature findings	**7**	CO3, CO 4	K1, K2, K3

	e. Referencing styles and citation management: Citation styles (APA, Vancouver, Harvard) and reference management software (Zotero, Mendeley, EndNote)			
Module 2:	**2.1 Basics of scientific writing** a. Purpose and ethics of scientific writing b. Structure of scientific papers: Introduction, methods, results, and discussion format c. Abstract and title formulation d. Writing effective introductions e. Clarity, precision, and objectivity in scientific language f. Common writing errors and how to avoid them g. Principles of paraphrasing, summarizing, and avoiding plagiarism.	**8**	CO3, CO 4, CO 5	K1, K2, K3, K4
	2.2 Ethics and laboratory safety a. Scientific Ethics: Definitions: ethics, scientific ethics, professionalism, Historical cases of ethical misconduct, Principles of autonomy, beneficence, non-maleficence, justice b. Bioethics in Biochemistry: Human research ethics; Animal ethics: 3Rs (Replacement, Reduction, Refinement); Genetic modification and ethics; Biosecurity. c. Laboratory Safety, Risk Assessment, and Emergency Procedures: Laboratory Fundamentals: Safe lab design, safety culture, documentation; Chemical Safety: Chemical handling, GHS classification, toxicology basics, and managing hazardous chemicals; Biological and Equipment Safety; and Emergency Preparedness.	**7**	CO2	K3, K4, K5
Module 3	**3.1 Advanced writing, communication and publication skills** a. Preparing dissertations and research manuscripts b. Writing materials & methods, results, and discussion sections c. Designing figures, tables, and captions. d. Writing cover letters, responses to reviewers, and research reports e. Preparing conference abstracts, posters, and oral presentations	**10**	CO3, CO4, CO5	K3, K4, K5

	f. Writing for different audiences (journals, funding agencies, public science communication) g. Journal selection, understanding impact factor h. Open-access publishing and publication ethics i. Manuscript submission process and peer review workflow			
	3.2 Proposal development a. Structure and components of a research proposal: Title, introduction, rationale, objectives, and hypothesis b. Materials and methods overview c. Expected results and significance of the study d. Formulation of aims and specific objectives: SMART (specific, measurable, attainable, relevant, time-bound) criteria for research objectives. e. Linking objectives to hypothesis and methodology.	**5**	CO3, CO4, CO5	K3, K4, K5
Module 4	**4. Basics of Biostatistics: Biological Data Characteristics, Error Analysis, and Data Representation** a. Characteristics of biological data: Variables and constants, discrete and continuous variables, relationship and prediction, variables in biology (measurement, ranked, attributes), derived variables (ratio, index, rates), types of measurements of biological data (interval scale, ratio scale, ordinal scale, nominal scale, discrete and continuous data). b. Elementary theory of errors: Exact and approximate numbers, source and classification of errors, decimal notation and rounding off numbers, absolute and relative errors, valid significant digits, relationship between number of valid digit and error, the error of sum, difference, product, quotient, power and root, rules of calculating digits. c. Data handling: Population and samples, random samples, parameter and statistics, accuracy and precision, accuracy in observations, Tabulation and frequency distribution, relative frequency distribution, cumulative frequency distribution. Graphical representation: types of graphs, preparation and their applications.	**15**	CO5	K1. K2, K3, K4, K5

	d. Concept of mean, median, mode, standard deviation and variance calculations			
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. D. Das, A. Basu, Research Methodology for Biological Sciences; Universities Press, Hyderabad, 1st Ed., 2020. 2. P. Trivedi, Research Methodology in Life Sciences; Pointer Publishers, Jaipur, 1st Ed., 2006. 3. J.R. Matthews, , R.W. Matthews, Successful Scientific Writing: A Step-by-Step Guide for the Biological and Medical Sciences; Cambridge University Press, Cambridge, 4th Ed., 2014. 4. R. de Souza, Scientific Communication in the Biological Sciences; Oxford University Press, New Delhi, 1st Ed., 2019. 5. K.L. Turabian, A Manual for Writers of Research Papers, Theses, and Dissertations; University of Chicago Press, Chicago, 9th Ed., 2018. 6. T. L. Beauchamp, J. F. Childress, Principles of Biomedical Ethics; Oxford University Press, New York, 8th Ed., 2019. 7. A. R. Gennaro, CRC Handbook of Laboratory Safety; CRC Press, Boca Raton, 6th Ed., 2014.			
References/ Readings:	1. C.R. Kothari, G. Garg, Research Methodology: Methods and Techniques; New Age International Publishers, New Delhi, 4th Ed., 2019. 2. R. Kumar, Research Methodology: A Step-by-Step Guide for Beginners; SAGE Publications, London, 5th Ed., 2019. 3. J.W. Creswell, J.D. Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches; SAGE Publications, Los Angeles, 5th Ed., 2018. 4. R.A. Day, B. Gastel, How to Write and Publish a Scientific Paper; Cambridge University Press, Cambridge, 7th Ed., 2012. 5. M. Alley, The Craft of Scientific Writing; Springer, New York, 4th Ed., 2018. 6. F. L. Macrina, Scientific Integrity: Text and Cases in Responsible Conduct of Research; ASM Press, Washington DC, 4th Ed., 2014. 7. National Research Council, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards; National Academies Press, Washington DC, 2011.			

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Discipline Specific Vocational Elective (DSVE) Courses

Title of the Course	Bioprospecting
Course Code	CHB-6401
Number of Credits	4 (2T + 2P)
Theory/Practical	Theory and Practicals
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 course	
Course Objectives:	• To understand ecosystems and sampling techniques for isolation of potential microorganisms and plants • To gain knowledge on the concept of bioprospecting of bioactive compounds from plant and microbial sources. • To acquire knowledge on screening, isolation, purification and characterisation of novel metabolites from biological sources using analytical techniques. • To explore bioprospecting techniques for exploring commercially important metabolites from plants and microbial sources.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. explain the concepts of sampling and exploration of plants and microorganisms from various ecosystems	PSO1, PSO2, PSO3

	CO 2. apply methods to screen, isolate, and characterise biomolecules from plant and microbial sources		PSO1, PSO2	
	CO 3. analyze the efficacy of purified biomolecules towards various applications in pharmaceutical, agricultural, environmental and green technology.		PSO2, PSO3	
	CO 4. design protocols for bioprospecting of commercially important metabolites from plants and microbial sources		PSO2, PSO4, PSO5	
Content:		**No. of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Introduction to Bioprospecting** Definition, scope, and significance, history and evolution of bioprospecting, role in drug discovery, agriculture, industry, and biotechnology; traditional knowledge and ethnobiology	**2**	CO1	K1, K2, K3
	1.2 Sources and Sampling of potential microbes and plants sources a. **Sources: microbes and plants** i. Marine and other coastal ecosystems: Water and sediment samples, microorganisms from mangroves, sand dunes and salterns. ii. Terrestrial: Forest/Ghats iii. Microbes in Extreme environments: thermophilic, psychrophilic, halophilic, alkaliphilic, barophilic b. **Sampling microorganisms** i. Niskin water sampler ii. Van Veen Grab sediment sampler c. **Aseptic collection of plant samples** i. Sampling of plants: Selection criteria: Type, physical condition, stage of growth, plant part.	**6**		

	ii. Sample treatment: surface sterilization, excision of desired plant component, extraction.			
	1.3 Case Studies and Success Stories a. Rosy periwinkle and vincristine/vinblastine b. Marine-derived compounds (e.g., bryostatin, salinosporamide)	**2**		
Module 2:	**2.1 Industrially and medically important biomolecules from plants and microorganisms:** Screening, detection, purification and characterization using analytical tools: a. Enzymes: extremozymes; food additives/ quality enhancers, medicine, antioxidants and antitumor agents b. Pigments: food colorants, fabric dyes c. Biocontrol agents: herbicides, pesticides d. Nanoparticles: medicine, drug carriers. e. Biofuels: microbially produced; plant based f. Optical and electronic devices: archaeal metabolites (bacteriorhodopsin and cell wall S-layer as membrane for ultrafiltration) g. Biopolymers: biodegradable plastics: PHAs, blended plastic polymers, EPS, biosurfactants and bioemulsifiers h. Plant growth promoters: gibberellins, auxins, cytokinins i. Pharmaceuticals: Antimicrobials, antitumour agents, drug carriers. j. Nutraceuticals: PUFAs, β-carotenes, antioxidants k. Cosmeceuticals: humectants (polyols). l. Drugs from Sea	**20**	CO2, CO3	K1, K2, K3, K4, K5, K6
PRACTICALS (2 Credit)				

Module 3:	**3.1 Sampling, Microbial Screening, and Phytochemical Analysis of microbial and Plant Samples- I** a. Sampling methods for collection of water and sediment samples from estuarine and coastal environments. b. Screening for phosphate-solubilizing bacteria from soil/water. c. Antioxidizing activity of plant extract by FRAP assay. d. Antidiabetic activity of plant extract by a-amylase (EC 3.2.1.1; Fungal Diastase ex. Aspergillus oryzae) inhibition assay. e. Estimation of total phenolic content of plant extracts. f. Extraction and spectrophotometric characterisation of pigments.	**24**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
	3.2 Sampling, Microbial Screening, and Phytochemical Analysis of microbial and Plant Samples- II a. Soxhlet extraction of phytochemicals and their TLC analysis. b. Biochemical identification of the phytochemicals in plant extracts. c. Steam distillation for the separation of essential oils. d. Assessment of microorganisms degrading chemical pesticides and determination of their degraded products. e. Strain improvement of microorganisms for lactose utilization by UV exposure. f. Extraction of pigments from plant/microbial sources using extraction techniques: Conventional extraction methods, Ultrasound assisted/ Microwave extraction method.	**36**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
Pedagogy:	**Theory**: Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. **Practicals**: Students will be given pre-lab and post-lab assignments on theoretical aspects of laboratory experiments prior to the conduct of each experiment. Sessions shall be interactive in nature to enable peer group learning.			
Texts:	1. U. Satyanarayana, U. Chakrapani, Biotechnology, Elsevier, India, 4th Ed., 2020.			

	2. J.P. Harley, L.M. Prescott, Laboratory exercises in Microbiology; The McGraw Hill companies, USA, 5th Ed., 2002. 3. K.R. Aneja, Experiments In Microbiology, Plant pathology and Biotechnology, New Age International Pvt. Ltd., New Delhi, India, 6th Ed., 2023.
References/ Readings:	1. R. Mitchell, J.D. Cu, Environmental Microbiology. Wiley-Blackwell Publication, Hoboken, New Jersey, 2nd Ed. 2009. 2. A. Altman, P. Hasegawa, Plant Biotechnology and Agriculture. Elsevier New York. 1st Ed. 2011. 3. D. Clark, N. Pazdernik, Biotechnology. Academic Press cell, Boston, 2nd Ed., 2015. 4. J. Pongracz, M. Keen, Medical Biotechnology. Churchill Livingstone, London, 2nd Ed. 2009 5. G. L. Fletcher, M.L. Rise, Aquaculture Biotechnology. Wiley, Canada, 1st Ed., 2011. 6. I. Ravi, M. Baunthiyal, J. Saxena, Advances in Biotechnology. Springer, New Delhi, 1st Ed., 2013. 7. S. Bieleck, J. Tramper, J. Polak, Food Biotechnology. Elsevier, London 1st Ed., 2000. 8. G. Svehla, Vogel's Text book of Quantitative Inorganic Analysis, Pearson Education, Asia, 5th Ed., 2000. 9. K. Wilson, J. Walker, Principles and Techniques of Practical Biochemistry. Cambridge University Press, Cambridge, 7th Ed., 2010. 10. S. K. Sawhney, Singh, R., Introductory Practical Biochemistry. Naros Publishing House, Harrow, UK., 1st Ed., 2005.
Web Resources:	1. https://doi.org/10.1021/acs.jnatprod.9b01285. 2. https://doi.org/10.1016/B978-0-444-64114-4.00001-7 3. https://doi.org/10.1016/B978-0-08-095167-6.00702-3. 4. https://doi.org/10.3390/molecules28114527 5. https://doi.org/10.1556/1886.2024.00035

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Title of the Course	Pharmaceutics and Food technology
Course Code	CHB-6402
Number of Credits	4 (2T + 2P)
Theory/Practical	Theory and Practicals
Level	500
Effective from AY	2026-27
New Course	NO
Bridge Course/ Value added Course	NO
Course for advanced learners	YES

Pre-requisites for the Course:	Nil	
Course Objectives:	• To understand the concepts of pharmaceutics, pharmacopeia and common pharmaceutical formulations- types and composition. • To learn the concepts of QC, QA, GLP and various testing protocols for raw materials and finished products in a pharma industry and food industry. • To acquaint with the fundamental concepts of food spoilage and food preservation. • To gain hands-on experience on analysis of nutrient content and quality of food.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. explain the significance of pharmacopeia and identify various drug formulations and their composition and describe the roles of QA and QC, interpret GMP and GLP guidelines.	PSO1, PSO3, PSO4

	CO 2. select and justify appropriate QC tests for various dosage forms and perform qualitative and quantitative estimation of pharmaceutical samples using various analytical techniques.		PSO3, PSO4, PSO5	
	CO 3. apply the concepts of food spoilage and food preservation in maintaining food safety and importance of nutrient content of foods.		PSO1, PSO4, PSO5	
	CO 4. analyze and determine nutrient content and quality of food samples.		PSO2, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Introduction to pharmaceutics and pharmaceutical industry** a. Importance of pharmaceuticals, drug development pipeline, Indian pharma industry regulation b. The Manufacturing workflow and quality systems	**1**	CO1	K1, K2
	1.2 Types of formulations: a. Tablets: advantages of tablets; types of tablets: effervescent, lozenges, chewable, buccal and sublingual, dispersible, orodispersible, soluble; excipients in tableting, coating in tablets. b. Granulation: methods and equipment, direct compression. c. Sustained release: Delayed absorption and/or a mixture of slow- and fast-release particles to produce rapid and sustained absorption in the same dose. d. Capsules: hard gelatin and soft gelatin capsules- differences and composition, advantages and limitations, Excipients in capsule. e. Liquids and Gels: Types of liquid formulations, excipients including solubilizers, stabilizers, buffers, tonicity modifiers, bulking agents, viscosity enhancers/reducers, surfactants, chelating agents and adjuvants, hydrophilic-lipophilic balance (HLB) values. f. Parenterals: Intravenous, subcutaneous, intramuscular or intra articular administration, stored in liquid form, or in lyophilized form if unstable.	**7**	CO1	K1, K2, K3, K4

	g. Topical: Cream, ointment, gel, paste, powder.			
Module 2:	**2.1 Quality assurance/ Quality control** a. Overview of Indian pharma regulations: CDSCO, Schedule M, Indian Pharmacopoeia Good Manufacturing Practices (GMP) as per Schedule; SOPs, Batch Records (BMR, MFR), Logbooks, Documentation control, deviation handling, CAPA (Corrective and Preventive Actions), Overview of Validation; Data integrity (ALCOA+), traceability in QA, Internal audits, self-inspection, regulatory audits; Sampling techniques (per IP), Good Laboratory Practices (GLP), Certificate of Analysis (CoA) and specification sheets b. Common QC tests on formulations: Tablets: weight variation, hardness, friability, disintegration, dissolution Capsules: weight variation, content uniformity, disintegration Oral liquids: pH, viscosity, microbial load, assay Injectables: sterility test, pyrogen test (LAL), particulate matter test, pH, clarity Topical formulations: viscosity, spreadability, pH, microbial testing QC sampling plans and specifications Microbial limit tests, sterility testing, Pyrogen/endotoxin test Shelf life determination, drug stability, real-time vs accelerated stability. c. Limit tests: chloride, sulphate, arsenic, lead, iron, nitrate, alkali and alkaline earth metals Limits of insoluble matter, soluble matter, nonvolatile matter, volatile matter, residue on ignition and ash value.	**7**	CO2	K1, K2, K3, K4, K5
Module 3	**3.1 Food Spoilage and Food Preservation** a. Forms of food spoilage: physical, chemical, microbiological parameters. b. Factors affecting the growth and survival of microorganisms in foods: Intrinsic and extrinsic factors c. Predictive food spoilage microbiology of milk, meat	**6**	CO3	K1, K2, K3, K4,K5

	d. Food preservation technologies: Thermal, Low temperature, irradiation, high pressure processing, modified atmospheres, preservatives (chemicals, natural organic molecules and enzymes).			
	3.2 Vitamins and minerals in health a. Fat soluble vitamins: physiological role, deficiency disorders, toxicity. b. Water soluble vitamins: physiological role, deficiency disorders, toxicity. c. Importance of Micro and macronutrients	**6**	CO3	K1, K2, K3, K4,K5
	3.2 Quality control and Quality Assurance in Food industries a. Microbiological examination of food, air and water in food industries. b. Hazard analysis and critical control point concept. c. Sanitation, Good lab practices (GLP), Good Manufacturing Practice (GMP) and Quality Systems in the food industry.	**3**	CO4	K1, K2, K3, K4,K5
PRACTICALS (2 credits)				
Module 4:	**4.1 Pharmaceutics (ANY EIGHT)** a. Physical examination of tablets: size, shape, color, friability, weight variation, and disintegration b. Estimation of Ca in pharmaceutical tablet by titrimetry. c. Estimation of Al and Mg in antacid tablet by titrimetry. d. Estimation of Paracetamol by titrimetry. e. Estimation of streptomycin in tablet sample by Maltol method. f. Study the dissolution rate of commercial tablets. g. Determination of moisture content in tablet powder by Karl Fischer titration. h. HPLC analysis of an analgesic (e.g. Ibuprofen)/ or any other drug with method development and validation. i. Determination of hardness of pharmaceutical tablet. j. UV Spectrophotometric Assay of the following drugs (in different dosage forms): Mefenamic acid/ Furosemide/ Chloramphenicol.	**32**	CO1, CO2	K1, K2, K3, K4, K5

	4.2 Laboratory analysis in food technology a. Estimation of vitamin C b. Estimation of Magnesium in food by titrimetric method. c. Estimation of enzymatic browning and non-enzymatic browning intensity. d. Determination of Iodine value of edible oils. e. Determination of peroxide value of edible oils. f. Determination of acid value of edible oils g. Titrimetric estimation of lactose in milk. h. Microbiological analysis of food and pharmaceutical samples	**28**	CO3, CO4	K1, K2, K3, K4, K5
Pedagogy:	**Theory**: Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. **Practicals**: Students will be given pre-lab and post-lab assignments on theoretical aspects of laboratory experiments prior to the conduct of each experiment. Sessions shall be interactive in nature to enable peer group learning.			
Texts:	1. L.L. Brunton, R. Hilal-Dandan, B.C. Knollmann, Goodman & Gilman's: The Pharmacological Basis of Therapeutics, McGrawHill Education, Columbus, Ohio, U.S., 13th Ed., 2018. 2. R.I. Mahato, A.S. Narang, Pharmaceutical Dosage Forms and Drug Delivery: Revised and Expanded, CRC Press, Boca Raton, FL, USA, 3rd Ed. 2017. 3. W.C. Frazier, C.W. Westhoff, Food Microbiology. Graw-Hill Companies, Inc., New York , 5th Ed 2017.			
References/ Readings:	1. M.E. Aulton, Pharmaceutics: The Science of Dosage Form Design, Churchill Livingstone; London 7th Ed., 1988. 2. M.E. Aulton, K. Taylor, Aulton's Pharmaceutics: The Design and Manufacture of Medicines, Elsevier, New York, 5th Ed., 2017, 3. L. Allen, N.G. Popovich, H. Ansel, Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincott Willimas & Wilkins, Philadelphia, 11th Ed., 2018 4. P.R. Hayes, Food Microbiology and Hygiene. Springer, New York. 2nd Ed. 1995. 5. K.E. Kniel, T.J. Montville, K.R. Matthews, Food Microbiology., ASM Press, NW Washington, USA., 4th Ed, 2017, 6. J.M. Jay, M.J. Loessner, D.A. Golden, Modern Food Microbiology. Springer Science, New York, 7th Ed, 2005,			

	7. M.R. Adams, M.O. Moss, Food Microbiology. Royal Society of Chemistry, Cryodon, UK, 4th Ed, 2015. 8. R. Mudambi, R. Sumathi, M.V. Rajagpal, Fundamentals of Food, Nutrition and diet therapy, New age International Publishers, India, 6th Ed, 1983. 9. R. C. Mendham, J. D. Denney, M. Barnes, B. Thomas, B. Sivasankar, Vogel's Text Book of Quantitative Chemical Analysis, Pearson, New Delhi, 6th Ed., 2009. 10. R.A. Day, A.L. Underwood, Quantitative Analysis, Pearson Education India, 6th Ed., 2015. 11. J. Kenkel, Analytical Chemistry for Technicians, Lewis publishers, USA, 3rd Ed., 2002. 12. N. Garg, K.L. Garg, K.G. Mukerji, Laboratory Manual of Food Microbiology. I.K. International Publishing House Pvt. Ltd., India, 1st Ed., 2010. 13. S.A. Sehgal, Laboratory Manual of Food Analysis. I.K. International Publishing House Pvt. Ltd., India, 1st Ed., 2016. 14. B. Poornima, Food Science & Quality Control. Centrum Press First, Inia, 2014. 15. A.Y. Sathe, A first course in Food Analysis. New Age International, India, 1999. 16. M.W. Connie, J. R. Daniel. The Food Chemistry Laboratory- A manual for Experimental Foods, Dietetics, and Food Scientists. 2nd Ed. Washington DC, 2005. 17. T. P. David, An introduction to practical Biochemistry. Tata McGraw Hill publishing Com. Ltd. New Delhi, 3rd Ed.,1992

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Title of the Course	Nanobiotechnology
Course Code	CHB-6403
Number of Credits	4 (2T + 2P)
Theory/Practical	Theory and Practicals
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To understand the unique properties of materials at the nanoscale and their relevance in nanobiotechnology. • To gain knowledge of synthesis methods and analytical techniques to investigate and evaluate nanobiotechnological systems. • To acquire deep understanding of principles and applications of nanotechnology in biological and medical fields, including diagnostics, drug delivery, and tissue engineering. • To explore the role of nanobiotechnology in agriculture and environmental sustainability through green nanotechnology approaches.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. describe the fundamental physical, chemical, and biological properties of materials at the nanoscale	PSO1, PSO3

	CO 2. apply the knowledge of green synthesis methods of nanomaterials for preparing nanoparticles		PSO1, PSO2, PSO3	
	CO 3. evaluate and select appropriate analytical techniques for characterizing nanoparticles.		PSO3	
	CO 4. analyze the efficacy of nanoparticles in various applications such as biomedical, industrial, environmental and agricultural.		PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Introduction to Nanobiotechnology:** a. Historical background; concepts. Fundamentals of Nanoscience- definition, scope, and historical development of nanotechnology; b. Biological cellular nanostructures Protein and Peptide based: Proteins; bilayers and membrane arrays; bacteriorhodopsins; eubacterial magnetosomes, DNA based: DNA molecule; self-assembled DNA nanotubes Virus particles; diatoms. c. Introduction to Nanomaterials: Nanoscale dimensions: spherical, triangular, prisms, rods, cubes. Nanoparticles, nanocrystals, quantum dots, nanotubes and nanowires. d. Nanoscale Properties: quantum effects, surface-to-volume ratio, Interdisciplinary nature and applications in biology and medicine; Miniaturized devices in nanobiotechnology - types and applications, lab-on-a-chip (LOC).	**7**	CO1	K1, K2, K3
	1.2 Types of nanomaterial, their synthesis and characterization a. Types of Nanomaterials- Metallic nanoparticles (Gold, Silver, Iron oxide), Carbon-based nanomaterials (Fullerenes, Carbon nanotubes, Graphene), Polymer-based nanoparticles and dendrimers, Liposomes, micelles, and biological nanoparticles b. Synthesis of Nanomaterials- Top-down and Bottom-up approaches, Physical, chemical, and biological methods of nanoparticle synthesis, Green synthesis using biological systems (plants, microbes, enzymes) c. Detection and characterization of nanoparticles Optical: Visual colour change; UV-Vis spectrum; Fluorescence. Size imaging: Electron microscopy (SEM, TEM), light	**8**	CO1, CO2	K1, K2, K3, K4

	scattering, Zetapotential Surface and composition: FT-IR, Raman spectroscopy, EDAX, AFM, XRD.			
Module 2:	**2. Applications of nanomaterials** **2.1 Biomedical Applications** a. Nanotechnology in Diagnostics- Biosensors: principles and design (electrochemical, optical, DNA-based), Quantum dots in bioimaging and diagnostics, Nanoparticles for early disease detection b. Nanomedicine- Targeted drug delivery systems using nanoparticles, Controlled release mechanisms, Nanocarriers in cancer therapy, antiviral and antimicrobial treatment c. Tissue Engineering and Regenerative Medicine: Nanomaterials for scaffolds and biomimetic design, Stem cell–nanomaterial interactions, Applications in wound healing and bone regeneration d. Toxicity and Biocompatibility: Cytotoxicity mechanisms and assays, Biodistribution, metabolism, and clearance of nanoparticles, Safety guidelines and ethical considerations in nanomedicine.	**8**	CO4	K2, K3, K4, K5
	2.2 Agricultural and Environmental Applications a. Environmental Nanobiotechnology- Nanomaterials in biosensing pollutants and environmental monitoring, Nanocatalysts in wastewater treatment, Green nanotechnology for sustainable development. b. Agricultural Nanobiotechnology- Introduction to Nanofertilizers, nanopesticides, and nano-based soil conditioners, Controlled nutrient delivery and crop protection.	**4**	CO4	K2, K3, K4, K5
	2.3 Industrial applications a. Industrial applications: Nanobiotechnology in food, cosmetics, and pharmaceuticals, Bio-nanocomposites and smart materials, Nanotechnology in energy and biofuels b. Future perspectives: Cutting-edge research and innovations in nanobiotechnology	**3**	CO4	K2, K3, K4, K5
PRACTICAL (2 credits)				
Module 4	**4.1 Green synthesis of nanoparticles**	**20**	CO2,	K2, K3,

	a. Biosynthesis of metal nanoparticles using plant extract. b. Optimization of Synthesis Conditions by varying parameters: pH, temperature, metal salt concentration and monitoring its impact on nanoparticle yield and stability		CO3	K4, K5, K6
	4.2 Characterization of nanoparticles a. Characterization of synthesized nanoparticles using UV-Vis spectroscopy. b. Characterization of Nanoparticles Using powder X-ray Diffraction (XRD) c. Characterization of Nanoparticles Using Fourier Transform Infrared Spectroscopy (FT-IR).	**12**	CO3	K2, K3, K4, K5, K6
	4.3 Biological and Environmental Applications a. Evaluation of Antimicrobial Activity by Agar well diffusion methods. b. Evaluation of Antimicrobial Activity by disk diffusion method. c. Evaluation of antioxidant activities of nanoparticles by FRAP assay. d. Evaluation of antidiabetic activity of nanoparticles by % inhibition of α-amylase (EC 3.2.1.1; Fungal Diastase ex. Aspergillus oryzae) activity assay. e. Evaluation of efficiency of synthesized nanoparticles for dye degradation studies.	**28**	CO3, CO4	K2, K3, K4, K5, K6
Pedagogy:	**Theory**: Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. **Practicals**: Students will be given pre-lab and post-lab assignments on theoretical aspects of laboratory experiments prior to the conduct of each experiment. Sessions shall be interactive in nature to enable peer group learning.			
Texts:	1. C. Nicolini, Nanobiotechnology & Nanobiosciences; Jenny Stanford Publishing, New York, 1st Ed., 2008. 2. M.M. DeVilliers, P. Aramwit, G.S. Kwon, Nanotechnology in Drug Delivery; Springer–American Association of Pharmaceutical Scientists Press, USA, 2009. 3. N. Yao, Z.L. Wang, Handbook of Microscopy for Nanotechnology; Kluwer Academic Publishers, USA, 2005.			
References/ Readings:	4. C.A. Mirkin, C.M. Niemeyer, Nanobiotechnology II: More Concepts and Applications; Wiley-Verlag GmbH & Co., Germany, 1st Ed., 2007. 5. J.W.M. Bulte, M.M.J. Modo, Design and Applications of Nanoparticles in Biomedical Imaging; Springer International Publishing, Switzerland, 2016. 6. P.P. Morajkar, M.M. Maik, Advances in Nano and Biochemistry: Environmental and Biomedical Applications, Elsevier Inc., Netherlands, 1st Ed., 2023.			

Web Resources:	https://doi.org/10.1002/3527602453.10.1007/978-1-59745-218-2

SEMESTER IV

Generic Elective (GE) Courses

Title of the Course	Biostatistics and Bioinformatics
Course Code	CHB-6201
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil
Course Objectives:	• To learn measures of central tendency, dispersion, and skewness to summarize and interpret biological data. • To administer skills in correlation, regression, probability distributions, and hypothesis testing to analyze relationships and make statistical inferences in biological studies. • To pursue foundational knowledge in bioinformatics, including biological databases, sequence analysis, and computational tools for molecular biology research. • To equip with computational and analytical skills in sequence alignment, phylogenetic analysis, protein structure prediction, and genome analysis for biological research applications.

Course Outcomes	The students will be able to:		**Mapped to PSO**	
	CO 1. evaluate and interpret central tendency, variability, and skewness measures to summarize biological datasets accurately.		PSO 3	
	CO 2. compute correlation and regression analyses, apply probability distributions, and conduct hypothesis tests to evaluate biological phenomena.		PSO 3	
	CO 3. analyze biological sequences from databases.		PSO 1, PSO 3, PSO 5	
	CO 4. perform computational analyses of biological sequences and utilize bioinformatics tools for genome and variant analysis.		PSO 3, PSO 5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Measures of Central tendency and dispersion** a. Measures of central tendency: characteristics of ideal measure, Arithmetic mean – simple, weighted, combined, and corrected mean, limitations of arithmetic mean; Median – calculation for raw data, for grouped data, for continuous series, limitations of median; Mode – computation of mode for individual series, by grouping method, in a continuous frequency distribution, limitations of modes; Relationship between mean, median and mode; mid-range. b. Measure of dispersion: variability, Range, mean deviation, coefficient of mean deviation, standard deviation (individual observations, grouped data, continuous series), variance, coefficient of variance, limitation Skewness – definition, positive, negative, purpose, measure, relative measure, Karl Pearson's Coefficient, Bowley's Coefficient, Kelly's Measure, Moments.	**15**	CO1	K1. K2, K3, K4, K5
Module 2:	**2. Correlation and regression analysis, Probability distributions, and hypothesis testing in Biostatistics** a. Correlation analysis: Correlation, covariance, correlation coefficient for ungrouped and grouped data, Pearson's Rank Correlation coefficient, scatter and dot diagram (graphical method). Regression analysis - Linear and exponential function - examples: DNSA conversion by reducing sugar, survival/growth of	**15**	CO1, CO2	K1. K2, K3, K4, K5

	bacteria, regression coefficients, properties, standard error of estimates, prediction, regression analysis for linear equation. b. Probability: Probability, combinatorial techniques, elementary genetics, Binomial, Poisson, Normal distributions. c. Hypothesis Testing: parameter and statistics, sampling theory, sampling and non-sampling error, estimation theory, confidence limits, testing of hypothesis, test of significance; Students' T-test, t-distribution, computation, paired t-test. Introduction to Chi-square test, F-test and ANOVA. d. Non-Parametric tests: Sign test, Mood's Median Test, Run Test, Wilcoxon Sign Rank test, Mann-Whitney U test, Kruskal-Wallis H test.			
Module 3	**3. Bioinformatics and Biological Databases** a. Bioinformatics: definition, scope, applications. b. Basics of molecular biology: DNA, RNA, proteins, genome organization. c. Biological databases: types and classification: i. Nucleotide sequence databases (GenBank, EMBL, DDBJ) ii. Protein sequence databases (UniProt, PDB) iii. Genome and specialized databases (Ensembl, RefSeq, KEGG) a. Database search tools – BLAST, FASTA, PSI-BLAST b. Sequence retrieval, annotation, and visualization c. Data formats and sequence file handling (FASTA, GenBank, GFF)	**15**	CO3	K1, K2, K3, K4, K5, K6
Module 4	**4. Sequence Analysis and Computational Tools** a. Pairwise sequence alignment: global (Needleman-Wunsch), local (Smith-Waterman) b. Multiple sequence alignment: ClustalW, MUSCLE, MAFFT c. Phylogenetic analysis – tree construction methods (UPGMA, NJ, Maximum Likelihood) d. Introduction to genome analysis – ORF prediction, gene finding, comparative genomics e. Metagenomics, DNA Barcoding and gene prediction	**15**	CO3, CO4	K1. K2, K3, K4, K5, K6

	f. Proteomics - Database searching (Mascot, SEQUEST), peptide mass fingerprinting and Protein structure prediction – homology modeling, secondary structure prediction g. Motif and domain analysis – Pfam, PROSITE, InterPro h. Molecular docking i. Bioinformatics tools for primer design, SNP analysis, and variant annotation			
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. A. Antonisamy, P.S. Premkumar, S. Christopher, Principles and Practice of Biostatistics; Elsevier India, 1st Ed., 2017. 2. P.N. Arora, P.K. Malhan, Biostatistics; Himalaya Publishing House, India., 9th Ed., 2006. 3. A. Annadurai, A Textbook of Biostatistics; New Age Publication, New Delhi, India,1st Ed., 2017.			
References/ Readings:	1. D.W. Mount, Bioinformatics: Sequence and Genome Analysis; Cold Spring Harbor Laboratory Press, New York, 2nd Ed., 2004. 2. A.M. Lesk, Introduction to Bioinformatics; Oxford University Press, New York, 5th Ed., 2013. 3. J. Pevsner, Bioinformatics and Functional Genomics; Wiley-Blackwell, New Jersey, 2nd Ed., 2015.			
Web Resources:	1. https://www.ncbi.nlm.nih.gov/ 2. https://www.uniprot.org/ 3. https://www.rcsb.org/			

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Title of the Course	Environmental Biochemistry
Course Code	CHB-6202
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	NO
Bridge Course/ Value added Course	NO
Course for advanced learners	NO

Pre-requisites for the Course:	Nil	
Course Objectives:	• To understand the classification, sources, and impacts of various environmental pollutants and their toxicological effects. • To learn methods and tools for monitoring environmental pollution, including microbial indicators and biosensors. • To explore physical, chemical, and biological remediation techniques for waste and pollution management • To study biotechnological approaches such as bioremediation, biofilters, and phytoremediation for sustainable pollution control.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. describe different environmental pollutants, their sources, toxicity, and ecological impact.	PSO2
	CO 2. apply various monitoring techniques to assess pollution levels using biological and chemical indicators	PSO4, PSO5

	CO 3. analyze and implement different waste treatment and remediation strategies, including biological systems		PSO4, PSO5	
	CO 4. evaluate and design biotechnological solutions for pollution control, including bioremediation and green technology approaches.		PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Environmental pollutants: source, effects, and their impact on health and environment** a. Environment and pollutants b. Classification and types of pollutants: Hydrocarbons and polymers; Agricultural chemicals (Pesticides, fertilizers); Heavy metals; Marine pollutants c. Toxicity, synergistic or antagonistic actions d. Eco-toxicology: permissible limits, ED50 & LD50 e. Acute and chronic exposures; biochemical effects and genotoxicity	**15**	CO1	K1, K2, K3
Module 2:	**2. Environmental monitoring parameters and pollution monitoring** **2.1 Significant environmental monitoring parameters** a. Dissolved oxygen b. Biochemical Oxygen Demand (BOD) c. Chemical Oxygen Demand (COD) **2.2 Environmental protection regulations, impact assessment, and standards** **2.3 Environmental pollutants and improper waste disposal** **2.4 Monitoring of pollution** a. Use of indicator microorganisms b. Biosensors	**9**	CO2	K1, K2, K3, K4
	2.3 Remediation of waste a. Concepts of reuse, recycle, recovery	**6**	CO2, CO3	K1, K2, K3, K4

	b. Waste treatment: wastewater/sewage, solid waste, hospital waste management c. Biological systems for remediation: plants, bacteria, fungi.			
Module 3	**3. Biotechnological Methods for Pollution Control** **3.1 Microbial consortia and related microbial processes** a. Enzymatic transformations by action of hydrolytic enzymes b. Co-metabolism c. Microbial adhesion, biofilms, extracellular polymers, and emulsifiers **3.2 Other pollutant removal techniques** a. Sedimentation b. Sorption c. Precipitation d. Speciation conversion	**8**	CO2, CO3	K2, K3, K4, K5
	3.3 Genetic and Molecular Tools in Pollution Control a. Genetically modified microorganisms (GMOs) for targeted degradation b. Genetic engineering of plants and microbes for enhanced bioremediation c. Biosensors for pollutant detection and monitoring **3.4 Case studies and applications** a. Bioremediation of oil spills b. Heavy metal remediation in mining areas c. Cleanup of pesticide-contaminated soils	**7**	CO2, CO3, CO4	K2, K3, K4, K5
Module 4	**4.1 Emerging eco-friendly alternatives** a. green chemistry and green technology **4.2 Biotechnological approaches to pollution control** a. Bioremediation: *in situ* and *ex situ,* factors affecting the process, microbial roles and evaluation b. Biotransformation	**15**	CO2, CO3, CO4	K2, K3, K4, K5

	c. Phytoremediation d. Biodegradation e. Biohydrometallurgy			
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. A. K. De, Environmental Chemistry, Wiley Eastern Ltd., New Delhi, 7th Ed., 2010. 2. U. Satyanarayana, U. Chakrapani, Textbook of Biotechnology, Books and Allied Pvt. Ltd., India, 12th Ed., 2019.			
References/ Readings:	1. G. M. Rand, S. R. Petrocelli, Fundamentals of Aquatic Toxicology: Effects, Environmental Fate, and Risk Assessment, Taylor & Francis, USA, 3rd Ed., 2019. 2. S. K. Agarwal, Environmental Biotechnology, APH Publishing Corporation, New Delhi, 2nd Ed., 2018. 3. S. E. Manahan, Environmental Chemistry. Lewis Publishers, USA. 7th Ed., 2000. 4. A. V. Salker, Environmental Chemistry. Narosa Publishing, New Delhi, 1st Ed., 2017. 5. S.M. Khopkar, Environmental Pollution Analysis. New Age International Pvt. Ltd., New Delhi, 2nd Ed., 2005.			
Web Resources:	https://doi.org/10.3390/toxics1008048410.1155/2012/450802			

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Title of the Course	Animal physiology and developmental biology
Course Code	CHB-6203
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	NO
Course for advanced learners	NO

Pre-requisites for the Course:	Nil.	
Course Objectives:	• To administer a fundamental knowledge on animal physiology • To develop insights into the functioning of physiological systems in human bodies. • To gain knowledge on fundamental concepts in developmental biology. • To learn the processes of morphogenesis and organogenesis in animals and to provide insights on the role of stems cells in therapy.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. apply the knowledge of structure and functions organs to explain physiological processes in human body.	PSO1, PSO2, PSO4, PSO5
	CO 2. explain the mechanisms of physiological processes in human body.	PSO1, PSO4
	CO 3. corelate the basic knowledge of developmental biology with the growth and	PSO1, PSO 4, PSO 5

	development in animals.			
	CO 4. illustrate the processes of morphogenesis and organogenesis in animals and develop strategies in using Stem cells for therapy.		PSO 1, PSO2, PSO3, PSO 4, PSO 5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Fundamental concepts in animal physiology-I** **1.1 Digestive system:** a. Composition and function, b. regulation of digestive juices, digestion, c. absorption of carbohydrate, proteins and fats of nucleic acids, minerals and vitamins. d. GI tract for drug absorption, distribution, metabolism and excretion	**5**	CO1, CO2	K1, K2, K3, K4
	1.2 Excretory system a. Structure of nephron b. Mechanism of urine formation, c. Renal clearance d. Composition of urine, e. Homeostasis: acid-base balance & imbalance. f. Role of kidney in drug metabolism and excretion	**6**	CO1, CO2	K1, K2, K3, K4
	1.3 Circulatory system a. Structure and function of heart b. Double circulation, pulmonary and systemic circulation c. Cardiac cycle and blood pressure d. Role of circulatory system in drug absorption, distribution studies.	**4**	CO1, CO2	K1, K2, K3, K4
Module 2:	**2. Fundamental concepts in animal physiology-II** **2.1 Locomotion and movement**	**5**	CO1, CO2	K1, K2, K3, K4

	a. Muscles: Structure and functions b. Bio-chemical characterization of extra cellular matrix, plasma lemma, transverse tubular system, sarcoplasmic reticulum and myofibrils. c. The sliding filament mechanisms and other theories metabolic and chemical changes during muscle constriction.			
	2.2 Reproductive system: a. Male reproductive system: Structure and function of male sex organs, role of hormones b. Female reproductive system: Structure and function of female sex organs, role of hormones, menstrual cycle, pregnancy, parturition, lactation.	**3**	CO1, CO2	K1, K2, K3, K4
	2.3 Hepatobiliary system: a. Anatomy of liver b. blood supply to liver c. Liver cells: hepatocytes, endothelial cells, Kupffer cells and parenchyma cells. d. Secretary and excretory functions of liver: Formation of bile and bilirubin; detoxification in liver; liver as organ for drug metabolism and excretion of drug; First-pass mechanism and Enterohepatic circulation of drug	**7**	CO1, CO2	K1, K2, K3, K4
Module 3:	**3. Concepts of Developmental biology** **3.1 Developmental biology** a. The origin of developmental biology- cell theory, mosaic and regulative development, discovery of induction, genetics and development **3.2 Basic Concepts of Development**: a. Potency, commitment, specification, induction, competence, determination, and differentiation b. Morphogenetic gradients c. Cell fate and cell lineages d. Stem cells	**7**	CO3, CO4	K1, K2, K3, K4

	e. Genomic equivalence and cytoplasmic determinants f. Imprinting g. Mutants and transgenics in the analysis of development			
	3.2 Gametogenesis, Fertilization, and Early Development a. Production of gametes b. Cell surface molecules in sperm-egg recognition in animals c. Zygote formation, cleavage, blastula formation, embryonic fields, gastrulation, and formation of germ layers in animals	**8**	CO3, CO4	K1, K2, K3, K4
Module 4:	**4. Morphogenesis and Organogenesis in animals and embryonic cell in therapy** **4.1 Morphogenesis and Organogenesis in animals** a. Cell aggregation and differentiation in Dictyostelium b. Axes and pattern formation in Drosophila, amphibia, and chick c. Organogenesis – vulva formation in Caenorhabditis elegans, eye lens induction, limb development, and regeneration in vertebrates d. Post-embryonic development: growth- cell proliferation, growth hormones; aging- genes involved in alteration in timing of senescence; regeneration– epimorphic regeneration of reptile (salamander) limb, requirement of nerves for the proliferation of blastema cells e. Environmental regulation of normal development f. Sex determination	**10**	CO3, CO4	K1, K2, K3, K4, K5
	4.2 Embryonic stem cells and their applications: Medical implications of developmental biology: genetic errors of human development- the nature of human syndromes– pleiotropy, genetic heterogeneity, phenotypic variability, mechanism of dominance; gene expression and human disease– inborn errors of nuclear RNA processing, inborn errors of translation; teratogenesis- environmental assaults on human development- teratogenic agents like alcohol, retinoic acid etc.	**5**	CO4	K1, K2, K3, K4, K5

Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Texts:	1. Stanfield, Principles of Human Physiology, Pearson/Benjamin Cummings, UK, 4th Ed., 2011. 2. Gilbert, S.F.; Barresi M. J.; Developmental Biology; Oxford University Press; UK., 12th Ed., 2020.
References/ Readings:	1. J.E. Hall, Guyton, Hall, Textbook of Medical Physiology. Saunders, Elsevier Inc., USA, 12th Ed. 2011. 2. K.E. Barrett, H.L. Brooks, S, Boitano, S.M. Barman, Ganong's Review of Medical Physiology, McGraw-Hill Medical, UK, 23rd Ed., 2009. 3. S.F. Gilbert, M.J. Barresi, Developmental Biology; Oxford University Press, UK, 12th Ed., 2020. 4. C. Moyces, P. Schulte, Principles of Animal Physiology, Pearson International Edition, USA, 2nd Ed., 2013.
Web Resources:	https://www.ncbi.nlm.nih.gov/books/NBK223690/

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Title of the Course	Hormones and Neurochemistry
Course Code	CHB-6204
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	NO
Bridge Course/ Value added Course	NO
Course for advanced learners	NO

Pre-requisites for the Course:	Nil	
Course Objectives:	• To develop knowledge on the human endocrine system and its role in human physiology. • To acquaint with the mechanism of hormone action, their regulation and clinical disorders associated with them. • To gain insights on structure, organization and functioning of nervous system and mechanisms of neuronal signalling. • To administer basic understanding on the significance of neurotransmitters and neuronal signalling in mental health and disorders.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. apply the knowledge of the signalling mechanisms of different hormones in human system.	PSO1, PSO2, PSO4, PSO5
	CO 2. correlate the diseases associated with hormonal imbalance and the biochemistry behind	PSO1, PSO2,

	them.			PSO4, PSO5
	CO 3. describe the organization and functions of nervous system and explain the pathways in neuronal signalling.			PSO1, PSO2, PSO4, PSO5
	CO 4. illustrate the role of neurotransmitters in signal generation and the biochemistry of mental disorders in the human body.			PSO1, PSO2, PSO4, PSO5
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Introduction to hormones** a. Definition, history, classification, and mechanism of action, History of hormones, Classification of hormones. b. Understanding of endocrine system, Pathways of hormone release, c. Signal transduction pathways, second messengers, regulation of signaling pathways. d. Hormones and their receptors: cell surface receptor, signaling through G-protein coupled receptors, Steroid hormone receptors, Thyroid hormone receptors e. Mechanism of sensitization and desensitization of hormone receptors	**6**	CO1	K1, K2, K3, K4
	1.2 Stimulus, regulation of biosynthesis and release of hormones a. Hypothalamic Hormones: CRH, TRH, GnRH, PRL/PRIH, GHRH/GHRIH b. Anterior Pituitary hormones: Growth hormone, Prolactin, POMC peptide family, LH, FSH, TSH c. Posterior pituitary hormones: Vasopressin, Oxytocin d. Adrenal Cortex Hormones: Aldosterone (renin angiotensin system) & cortisol e. Hormones of adrenal medulla: Epinephrine and norepinephrine f. Hormones regulating Ca2+ homeostasis: PTH, Vitamin D, Calcitonin. g. Pancreatic Hormones: Insulin, Glucagon. h. GI tract Hormones: Gastrin, Secretin, CCK, GIP, Ghrelin.	**9**	CO1	K1, K2, K3, K4,K5
Module 2:	**2.1 Reproductive hormones and hormones by organs with endocrine function:**	**6**	CO2	K1, K2,

	a. Reproductive Hormones: Male and female Sex hormones, interplay of hormones during reproductive cycle, pregnancy, parturition and lactation. Introduction to rapid test for pregnancy. b. Role of oral contraceptives. c. Other organs with endocrine function: Heart (ANP), Kidney (erythropoietin), Liver (angiotensinogen, IGF-1), adipose tissue (leptin, adiponectin); growth factors: PDGF, EGF, IGF-I, -II.			K3, K4,K5
	2.2 Biochemistry and diseases associated with hyper or hypo secretion: a. Hypothalamus and pituitary associated hormonal conditions: Goiter, Graves' disease, Cretinism, Myxedema, Hashimoto's disease, Gigantism, Acromegaly, dwarfism. b. Adrenal cortex-associated hormonal conditions: Addison's disease, Conn's syndrome, Cushing's syndrome, c. Calcium homeostasis-related hormonal conditions: Rickets, Osteomalacia, Osteoporosis. d. Pancreatic hormone-associated hormonal conditions: Diabetes insipidus.	**9**	CO2	K1, K2, K3, K4, K5
Module 3:	**3. Nervous system and neuronal signalling** **3.1 Structure and organization of Nervous system:** a. Brain anatomy b. Central Nervous system and Peripheral nervous system c. Blood Brain Barrier d. Cerebrospinal fluid: composition, function and circulation	**4**	CO3	K1, K2, K3, K4
	3.2 Structures and Functions of nerve cells and membrane transport: a. Cellular components of nervous system: Nerve, neuron, neuroglial cells. b. Structure and function of nerve cell membranes. c. Membrane transport: Primary ion transporters, Ca^{2+} pumps, V-ATPase pump, secondary active transport, cation antiporters, facilitators.	**3**	CO3	K1, K2, K3, K4
	3.3 Energy metabolism in brain:	**3**	CO3	K1, K2,

	a. Cerebral energy metabolism: Substrates for cerebral energy metabolism, regulation of the cerebral metabolic rate, glycolysis, glycogen metabolism, Pentose, phosphate shunt, Malate–aspartate shuttle, lactate metabolism, TCA, Glutamate/glutamine metabolism.			K3, K4
	3.4 Synaptic Transmission: a. Synapse structure b. Chemical and Electrical synapses c. Membrane potential in steady state d. Action potential generation and propagation e. Pre and post synaptic events	**5**	CO3	K1, K2, K3, K4, K5
Module 4:	**4. Neurotransmitters in mental health and disorders** **4.1 Neurotransmitters and neuromodulators: Structure, functions, metabolism, receptors:** a. Acetylcholine b. Excitatory Amino Acids (EAAs): Glutamic Acid, c. Inhibitory Amino Acids (IAAs): γ-Aminobutyric Acid and Glycine, d. Serotonin (5-HT), Catecholamine, e. Purines (Cannabinoids) f. Neuropeptides g. Nitric oxide	**4**	CO3, CO4	K1, K2, K4, K5
	4.2 Sensory transduction: Vision, Olfaction and taste, Hearing and balance, touch	**3**	CO3, CO4	K4, K5
	4.3 Biochemistry of memory; mental and neurodegenerative disease: a. Biochemistry of memory: Learning and memory; Divisions of memory (Qualitative and Quantitative categories); Synaptic signalling in learning and memory b. Mental illness: Depression, Schizophrenia c. Neurodegenerative diseases: Alzheimer's disease, Parkinson's disease, Huntington's	**5**	CO3, CO4	K4, K5

	disease, Dementia			
	4.4 CNS drugs: definition, types and modes of action	**3**	CO3, CO4	K4, K5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments /presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. J.M, Berg, L. Stryer, J. Tymoczko, G. Gatto, Biochemistry. W.H. Freeman and company, USA, 8th Ed., 2019. 2. D. L. Nelson, M. M. Cox, A.L. Lehninger, Lehninger Principles of Biochemistry. W.H. Freeman and company, USA, 7th Ed., 2017.			
References/ Readings:	1. C.U.M. Smith, Elements of Molecular Neurobiology. John Wiley & Sons Ltd., USA, 3rd Ed., 2002. 2. E.R. Kandel, J.H. Swartchz, T.M. Jesselle, Principles of Neural science. McGraw-Hill, New York, 6th Ed., 2000. 3. B. Kline, W.G. Rossmanith, Hormones and the endocrine system. Springer, Cham., Switzerand, 1st Ed. 2016. 4. C.K. Mathews, K.E. van Holde, K.G. Ahern, Biochemistry. Pearson Publishers, USA, 4th Ed., 1999. 5. I.R. Ilie, Introduction to endocrinology. Springer Nature, Switzerland, 1st Ed., 2020. 6. A. W. Norman, G. Litwack, Hormones. Academic press, California, USA, 2nd Ed., 1997. 7. G. David, S. Dolores, Greenspan's Basic and Clinical Endocrinology. Mc Graw Hill Education, USA, 10th Ed., 2018, 8. A. Belfiore, D. Leroith, Principles of Endocrinology and hormone action. Springer, 1st Ed., 2018. 9. R.W. Albers, S.T. Brady, D. L. Price, Basic neurochemistry: Molecular, cellular and medical aspects. Elsevier Academic Press publishers, Philadelphia, 7th Ed.,2006. 10. B. Mathew, T. Parambi, Principles of Neurochemistry: Fundamentals and Applications. Springer, Singapore, 1st Ed., 2020.			

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Title of the Course	Advanced Practical in Biochemistry-I
Course Code	CHB-6205
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2026-27
New Course	YES
Bridge Course/ Value added Course	NO
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To gain experimental knowledge in handling and testing microbial pathogens, and antimicrobial agents in a microbiological laboratory. • To develop hands-on skills in biochemical and analytical techniques for assessing environmental samples such as water, soil, and sewage • To understand the role of plant growth promoting microorganisms in plant growth and development • To equip with fundamental statistical techniques for organizing data, visualizing distributions, and analyzing relationships between variables	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. identify and classify human microbiota and microbial pathogens from specimens and choose the technique to study the effectiveness of antimicrobial agents	PSO1, PSO2, PSO3, PSO4, PSO5
	CO 2. perform key environmental biochemistry assays and analyses, interpret pollutant data,	PSO1, PSO2,

	and evaluate water and soil quality using standard laboratory methods.			PSO3, PSO4, PSO5
	CO 3. apply the knowledge of plant growth promoting microbes in developing biofertilizers and biopesticides.			PSO1, PSO2, PSO3, PSO4, PSO5
	CO 4. analyze frequency distributions, create graphs, perform regression, calculate correlation, and interpret results.			PSO1, PSO3, PSO4, PSO5
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Microbes in health and disease** a. Isolation of normal microbiota from the human body: Skin, oral, respiratory microflora. b. Examination of spirochaetes from oral plaque by silver staining technique (Fontana's method). c. Microscopic examination of malarial parasite in blood film using Giemsa stain. d. Primary isolation of enteric pathogens (*Salmonella, Shigella, Vibrio*) on selective and differential culture media. e. Evaluation of effectiveness of chemical antimicrobial activity of antiseptics by filter paper disk method/ phenol coefficient method. f. Evaluation of antimicrobial activity of ethanol as a skin degerming agent.	**30**	CO1	K4, K5
Module 2:	**2. Environmental Biochemistry** a. Estimation of nitrate using spectrophotometric method. b. Isolation of Escherichia coli Bacteriophages from sewage sample. c. Estimation of total phosphorus using spectrophotometric method. d. HPLC analysis of pharmaceutical/agro based pollutants in water/soil. e. Estimation of total dissolved and suspended solids (TDS and TSS) in water sample. f. Determination of water hardness by titration using disodium salt of ethylenediaminetetraacetic acid (Na2-EDTA). g. Determination of dissolved CO_2 in water samples.	**32**	CO2	K3, K4, K5, K6

Module 3:	**Agricultural biochemistry** a. Physical analysis of soil fertility: pH, moisture content, water holding capacity, percolation and capillary action. b. Assessment of rhizospheric microorganisms with agricultural potential: i. Estimation of indole acetic acid by Salkowski's method. ii. Estimation of ammonia using Nessler's reagent iii. Assessment for hydrogen cyanide producers iv. Determination of nitrate production using Griess-Ilosvay reagent c. Effect of microbial consortia on seed germination.	**30**	CO3	K4, K5, K6
Module 4:	**Biostatistics and Bioinformatics** a. Grouping of data and preparation of frequency distribution (Histogram and frequency polygon) b. Curve Fitting of straight line (simple linear regression) c. Two way ANOVA by calculation and using software d. Measure of Pearson's correlation coefficient (r) in excel and test of overall significance (for grouped and ungrouped data) e. Computation of non-parametric tests - Kruskal-Wallis Test and Wilcoxon-signed rank test f. Retrieval of nucleotide and protein sequences from GenBank and UniProt. g. Database Searches and Similarity Analysis by BLAST and FASTA searches. h. Use of BioEdit for nucleotide sequence editing and alignment i. Sequence Alignment and Motif/Domain Analysis: Pairwise and multiple sequence alignment (ClustalW/ MUSCLE). j. Construction of phylogenetic trees (UPGMA/ Neighbor-Joining). k. Molecular docking (using software like SwissDock/AutoDock)	**28**	CO4	K4, K5, K6
Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.			

Texts:	1. J.P. Harley, L.M. Prescott, Laboratory exercises in Microbiology; The McGraw Hill companies, 5th Ed., 2002. 2. K.R. Aneja, Experiments In Microbiology, Plant pathology and Biotechnology, New Age International Pvt. Ltd., New Delhi, India, 6th Ed., 2023.
References/ Readings:	1. S. C. Gupta, Fundamentals of Statistics, Himalaya Publishing House, Mumbai, 8th Ed., 2021. 2. S. M. Khopkar, Environmental Pollution Analysis: A Practical Guide, New Age International, New Delhi, 2nd Ed., 2005 3. A. V. Salker, Environmental Chemistry: Pollution and Remedial Perspective, Narosa Publishing House Pvt. Ltd., New Delhi, 1st Ed., 2017. 4. C. N. Sawyer, P. L. McCarty, G. F. Parkin, Chemistry for Environmental Engineering and Science, McGraw-Hill, New York, 5th Ed., 2003. 5. N. H Bergman, Comparative Genomics, Humana Press, Totonawa, New Jersey, 1st Ed. 2007.
Web Resources:	1. https://www.ncbi.nlm.nih.gov/genbank/ 2. https://www.uniprot.org/help/blast-submission

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Title of the Course	Advanced Practical in Biochemistry-II
Course Code	CHB-6206
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2026-27
New Course	YES
Bridge Course/ Value added Course	NO
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To acquaint with experiments and techniques used in food and industries. • To train in analyzing food quality, contaminants, and adulterants. • To gain hands-on experience in staining techniques for cell and molecular biology. • To familiarize with industrial and research practices in the field of Biochemistry.	
Course Outcomes: **Course Outcomes:**	Students will be able to:	**Mapped to PSO**
	CO 1. demonstrate experimental strategies for analyzing food samples involving food safety, adulterants; nutritional value of food.	PSO1, PSO2, PSO3, PSO4, PSO5
	CO 2. explain experimental strategies for food processing.	PSO1, PSO3, PSO4
	CO 3. identify cell components based on staining techniques.	PSO1, PSO3, PSO4, PSO5

	CO 4. corelate theoretical biochemistry concepts with industrial and research practices during the field trip.		PSO1, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Advanced Food and Industrial Biochemistry** **(from a-g of 4h each; from h-k of 8h each)** a. Estimation of Beta-Carotene in food sample b. Estimation of lycopene in food sample c. Determination of quality of milk and milk products by Resazurin test d. Determination of adulterants in food: (metanylyellow-turmeric, congo red-chilli powder) e. Determination of iron content in food by iron thiocyanate method f. Estimation of anti-nutritional factors in food: phytate g. Isolation of Starch and characterization from potato. h. Bioassay for penicillin i. Production of Sauerkraut using lactic acid bacteria. j. Isolation of antibiotic-resistant bacteria by Replica plating technique. k. Cultivation of oyster mushrooms.	**60**	CO1, CO2	K4, K5
Module 2:	**2. Staining techniques in cell and molecular biology** a. Capsule staining by positive staining techniques b. Endospore staining by Schaeffer-Fulton method. c. Demonstration of Agarose gel electrophoresis with SyBr green stain. d. Demonstration of SDS PAGE analysis with silver staining e. Examination of lignin in plant tissue by Wiesner staining technique using Phloroglucinol-HCl stain.	**30**	CO3	K4, K5
Module 3:	**3. Field trip**	**30**	CO4	K4, K5,

	a. Visit to National Research Institutes in Goa: National Institute of Oceanography (CSIR-NIO); Indian Council of Agricultural Research – Central Coastal Agricultural Research Institute (ICAR - CCARI) / Indian Council of Medical Research- National Institute of Malarial Research (ICMR-NIMR) b. Visit to institutes: Birla Institute of Technology and Sciences (BITS) Pilani, Goa Campus/IIT, Goa campus. c. Visit to pathology laboratories: Pathology/ Biochemistry laboratory at Goa Medical College/Private pathological laboratories. d. Visit to industries: Pharmaceutical industries; Food and beverage industries.			K6
Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.			
Texts:	1. J.P. Harley, L.M. Prescott, Laboratory exercises in Microbiology; The McGraw Hill companies, 5th Ed., 2002. 2. K.R. Aneja, Experiments In Microbiology, Plant pathology and Biotechnology, New Age International Pvt. Ltd., New Delhi, India, 6th Ed., 2023.			
References/ Readings:	1. R. M. Harrison, Practical Environmental Biochemistry, Royal Society of Chemistry, Cambridge, 1st Ed., 2001. 2. S.K. Yadav, R. Gupta, S. Singh, Clinical Laboratory Management, Springer Cham, New York, 1st Ed., 2024. 3. Connie M. Weaver and James R. Daniel. The Food Chemistry Laboratory- A manual for Experimental Foods, Dietetics, and Food Scientists, Washington DC, 2nd Ed., 2005. 4. D. T. Plummer. An introduction to practical Biochemistry. Tata McGraw Hill publishing Com. Ltd. New Delhi, 3rd Ed., 1992.			

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Title of the Course	Advanced Practical in Biochemistry-III
Course Code	CHB-6207
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2026-27
New Course	YES
Bridge Course/ Value added Course	NO
Course for advanced learners	NO

Pre-requisites for the Course:	Nil	
Course Objectives:	• To acquaint with experiments and techniques used in food and industries. • To train in analyzing food quality, contaminants, and adulterants. • To gain hands-on experience in staining techniques for cell and molecular biology. • To familiarize with industrial and research practices in the field of Biochemistry.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. demonstrate experimental strategies for analyzing food samples involving food safety, adulterants; nutritional value of food.	PSO1, PSO2, PSO3, PSO4, PSO5
	CO 2. explain experimental strategies for food processing.	PSO1, PSO2, PSO3, PSO4, PSO5
	CO 3. identify cell components based on staining techniques.	PSO1, PSO2,

			PSO3, PSO4, PSO5	
	CO 4. corelate theoretical biochemistry concepts with industrial and research practices during the field trip.		PSO1, PSO2, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Advanced Food and Industrial Biochemistry** **(from a-e of 4h each; from f-k of 8h each)** a. Estimation of astaxanthin in vegetable. b. Determination of quality of milk and milk products using MBRT. c. Determination of adulterants in food: (water in milk, papaya seeds in pepper, honey) d. Estimation of anti-nutritional factors in spinach: oxalates. e. Isolation of Cholesterol and lecithin from egg. f. Isolation and identification of fungi in stored food grains. g. Isolation and identification of microorganisms on surfaces: pre and post sanitation. h. Bioassay for nicotinic acid i. Isolation of antibiotic-resistant bacteria by gradient plate technique. j. Cultivation of button mushrooms.	**60**	CO1, CO2	K4, K5
Module 2:	**Advanced biochemistry** a. Flagella staining by Liefson's stain b. Metachromatic granule staining by Albert's Staining technique c. Sphaeroplasts/ protoplasts from gram-negative/Gram-positive bacteria d. Separation of cellular components using differential centrifugation technique. e. Separation of DNA/RNA/proteins using density gradient centrifugation.	**30**	CO3	K4, K5
Module 3:	**4. Field trip** a. Visit to National Research Institutes in Goa: National Institute of Oceanography (CSIR-NIO); Indian Council of Agricultural Research – Central Coastal	**30**	CO4	K4, K5

	Agricultural Research Institute (ICAR - CCARI) / Indian Council of Medical Research- National Institute of Malarial Research (ICMR-NIMR) b. Visit to institutes: Birla Institute of Technology and Sciences (BITS) Pilani, Goa Campus/IIT, Goa campus. c. Visit to pathology laboratories: Pathology/ Biochemistry laboratory at Goa Medical College/Private pathological laboratories. d. Visit to industries: Pharmaceutical industries; Food and beverage industries.			
Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.			
Texts:	1. J.P. Harley, L.M. Prescott, Laboratory exercises in Microbiology; The McGraw Hill companies, 5th Ed., 2002. 2. K.R. Aneja, Experiments In Microbiology, Plant pathology and Biotechnology, New Age International Pvt. Ltd., New Delhi, India, 6th Ed., 2023.			
References/ Readings:	1. R. M. Harrison, Practical Environmental Biochemistry, Royal Society of Chemistry, Cambridge, 1st Ed., 2001. 2. S.K. Yadav, R. Gupta, S. Singh, Clinical Laboratory Management, Springer Cham, New York, 1st Ed., 2024. 3. Connie M. Weaver and James R. Daniel. The Food Chemistry Laboratory- A manual for Experimental Foods, Dietetics, and Food Scientists, Washington DC, 2nd Ed., 2005. 4. D. T. Plummer. An introduction to practical Biochemistry. Tata McGraw Hill publishing Com. Ltd. New Delhi, 3rd Ed., 1992.			

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DISSERTATION (40 Credits)

Title of the Course	Discipline Specific Dissertation (DSD)
Course Code	CHB-6501
Number of Credits	40
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To learn to identify a research problem and review scientific literature critically. • To develop a well-structured research experimental design. • To execute the research plan, critically analyze and interpret the results. • To present the research findings by writing a thesis and presentation.	
Course Outcomes	The students will be able to:	**Mapped to PSO**
	CO 1. identify a research gap and formulate a research problem based on a comprehensive literature review.	PSO1, PSO2, PSO3, PSO4, PSO5
	CO 2. integrate theoretical knowledge with practical applications to design a well-	PSO1, PSO2, PSO3, PSO4,

	structured research experimental methodology.		PSO5	
	CO 3. conduct the experiments, analyse, interpret and validate experimental results with scientific reasoning.		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 4. present the research findings in the form of thesis and presentations.		PSO1, PSO2, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
	As per OA-35A	1200	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Dissertation carried out individually by each student throughout the academic year.			
Texts:	As required for the development of review and methodology.			
References/ Readings:	As required for the development of review and methodology.			
Web Resources:	As required for the development of review and methodology.			

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DISSERTATION (20 Credits)

Title of the Course	Discipline Specific Dissertation (DSD)
Course Code	CHB-6502
Number of Credits	20
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To learn to identify a research problem and review scientific literature critically. • To develop a well-structured research experimental design. • To execute the research plan, critically analyze and interpret the results. • To present the research findings by writing a thesis and presentation.	
Course Outcomes	The students will be able to:	**Mapped to PSO**
	CO 1. identify a research gap and formulate a research problem based on a comprehensive literature review.	PSO1, PSO2, PSO3, PSO4, PSO5
	CO 2. integrate theoretical knowledge with practical applications to design a well-	PSO1, PSO2, PSO3, PSO4,

	structured research experimental methodology.		PSO5	
	CO 3. conduct the experiments, analyse, interpret and validate experimental results with scientific reasoning.		PSO1, PSO2, PSO3, PSO4, PSO5	
	CO 4. present the research findings in the form of thesis and presentations.		PSO1, PSO2, PSO3, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
	As per OA-35A	600	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Dissertation carried out individually by each student throughout the academic year.			
Texts:	As required for the development of review and methodology.			
References/ Readings:	As required for the development of review and methodology.			
Web Resources:	As required for the development of review and methodology.			

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